Course syllabus

Ång- och gasturbiner för hållbar kraftproduktion - med flygmotorer Steam and Gas Turbines for Renewable Power Production - with Aero-engines

MVKN76, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED M
Date of Decision: 2023-04-11

General Information

Elective for: M5-en, W5-et
Language of instruction: The course will be given in English

Aim

The course aims to provide the students with knowledge and understanding concerning the prime movers for sustainable thermal power generation, namely gas- and steam turbines. In addition to the turbomachinery part, a particular focus will be directed towards renewable applications. The latter is essential because flexible dispatchable power plants could be seen as enablers for other renewable production means such as wind- and solar power. The course will cover general applications of gas- and steam turbines, cycles, and the involved components in gas turbines. The course will provide necessary skills in problem-solving concerning energy balances at component and system level, basic one- and two-dimensional aerothermal design of the involved components and more detailed topics such as losses, etc. The students should reach the ability to understand and apply the theory to real engineering problems.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- Understand the application of gas- and steam turbines in a renewable electrical system
- Explain the fundamental thermodynamics, aerodynamics (diffusion and expansion), and velocity triangles. The course focus is directed towards the design principles rather than detailed discussions related to particular tools such as CFD.
- Understand basic turbomachinery working principles and selection of suitable machine types
- Understand the various gas turbine schemes (spools, inter-cooling, and reheat)
- Explain the basic working principles of the thermodynamics of the involved engine components and combined cycles
- Understand aero-engine design and application
- Explain the basic working principle and aerodynamics of centrifugal compressors
- Explain the working principle and aerodynamics of axial compressors
- Understand the fundamental combustion process, emissions, and limitations within the combustion system
- Explain the working principle of axial- and radial turbines and aerodynamics
- Understand features of gas turbines off-design operation – including hydrogen and aspects of biogas combustion

Competences and skills
For a passing grade the student must

- Describe various means of renewable power generation
- Describe the underlying working principles of the involved components
- Analyze component performance based on velocity triangles and loss models
- Review methods for the analysis of the performance of turbomachinery

Judgement and approach
For a passing grade the student must

- Participate in discussions and judgment of relevant problems related to gas and steam turbines
- To present analysis and synthesis of basic phenomena and governing equations for the involved turbomachinery components

Contents

The course covers two critical prime movers, namely gas- and steam turbines. Both should be seen as essential means of flexible power generation in a renewable context as well as enablers for other non-dispatchable production means such as wind- and solar power. The course will cover a range of gas turbine applications for power generation and mechanical drive and some aero-engine technology. Besides applications, the relevant thermodynamic processes as well as the required basic aerodynamics for a range of components, are integral parts within the course. It should be emphasized, however, that despite state-of-the-art CFD-tools, most design features are set at the one- and two-dimensional levels.

The focus of the course will therefore be directed toward that level of design rather than CFD (well covered in other courses). There will be a large focus on aspects of operational flexibility and renewable fuels, which will be indeed important in our future energy systems worldwide.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: A written exam, including mainly theoretical/descriptive questions and simple problems, has to be passed at the end of the course. The maximum number of credit points on the exam is 50 p. The grading requirements are 50%, 75%, and 85%

for grades 3, 4, and 5, respectively. The mandatory home assignments must be fully completed and approved before the written exam.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Admission

Admission requirements:

- MMVF01 Thermodynamics and Fluid Mechanics or MVKF30 Thermodynamics for Energy Engineers

Assumed prior knowledge: MVKN60 Theory of Turbomachinery or similar.
The number of participants is limited to: No
The course overlaps following course/s: MVKN75

Reading list

- Cohen, H.; Rogers G.F.C.; Saravanamuttoo, H.I.H : Gas Turbine Theory 5th edition, Pearson Education 2001. ISBN:0-13-015847-x and hand-outs regarding combustion.

Contact and other information

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