Turbomachines

Course Number: 33-31-024-31

Course Content:

1- Introductory Remarks
2- Applied Fluid Dynamics in Turbomachinery
3- Applied Thermo Dynamics in Turbomachinery
4- Applied Dimensional Analysis in Turbomachinery
5- Radial Flow (Centrifugal) Pumps and Compressors
6- Axial Flow Gas Turbines
7- Steam Turbines
8- Axial Flow Compressors
9- Radial Flow Turbines
10- Other Rotodynamic Machines

Course Description:

Mechanical engineering students can take a course on turbomachines near the end of the BSc program. It is wise to take this course, because turbomachines are fantastic show rooms for the applications of thermo-fluid sciences. Besides, pumps, turbines and compressors are so extensively used in industries and even household devices and systems, that familiarity with them is a must for a mechanical engineer. This course looks at turbomachines from an energy exchange point of view. We want to know how the geometry, flow variables and performance parameters are inter-related.

Chapter 1 provides some general background information including a historical review and some commonly used classifications.

Chapter 2 is a short review on fluid mechanics as applied to turbomachines. Parameters used to describe and/or evaluate internal and external flows are discussed in this Chapter. Also proper forms of mass and momentum balance equations are presented. A convenient way to describe the flow in a turbomachine, i.e. velocity triangle, gets our attention here as well.

Chapter 3 is a short review on thermodynamics as applied to turbomachines. Here the energy balance and energy-related variables are the major players. Various definitions of efficiency and loss parameters are discussed in this Chapter and the importance of the Mollier diagram in thermal machines is stressed here.

Chapter 4 briefly reviews the principles and methods of dimensional analysis and provides means to describe and evaluate turbomachines via a fewer number of physically desirable non-dimensional parameters. Some important performance charts are also presented in this Chapter.

Chapter 5 introduces radial flow pump configurations and parts and applies the thermo-fluid principles to these machines to obtain formulas appropriate for the preliminary analysis and design. A variety of technical and performance problems related to centrifugal pumps and compressors and their applications are discussed in this Chapter.

Chapter 6 introduces axial flow gas turbine configurations and parts and applies the thermo-fluid principles to these machines to obtain formulas appropriate for the preliminary analysis and design. A variety of technical and performance problems related to axial flow gas turbines and their applications are discussed in this Chapter.

Chapter 7 briefly discusses axial flow steam turbines as compared to the gas turbines.

Chapter 8 introduces the axial flow compressor configurations and parts and applies the thermo-fluid principles to these machines to obtain formulas appropriate for the preliminary analysis and design. A variety of technical and performance problems related to axial flow compressors and their applications are discussed in this Chapter.

Chapter 9 introduces the radial flow turbine configurations and parts and applies the thermo-fluid principles to these machines to obtain formulas appropriate for the preliminary analysis and design. A variety of technical and performance problems related to radial flow turbines and their applications are discussed in this Chapter.

Chapter 10 is a regulatory Chapter in this course. Depending on the time available and interests of the students, relevant topics related to axial flow pumps, fans and blowers, hydraulic and wind turbines are presented.

Course Resources:

The following textbooks are recommended for this course:

[1]- S. L. Dixon and C. A. Hall, Fluid Mechanics and Thermodynamics of Turbomachinery, 6^{th} edition, Elsevier, 2010.

[2]- S. M. Yahya, Turbines, Compressors and Fans, Tata Mc Graw Hill, 2005.

[3]- W. Peng, Fundamentals of Turbomachinery, 2008.

[4]- A. T. Sayers, Hydraulic and Compressible Flow Turbomachines, 2003.

[5]- R. K. Turton, Principles of Turbomachinery, E and F. N. Spon, 1984.

There are also a number of Persian books on turbomachines written by my Iranian colleagues. Among them, I am familiar with the books written by Professor Shirani (Isfahan University of Technology) and Professor Nourbakhsh (University of Tehran) and would like to recommend these books as well. Many translated books have also been published. I have not used the translated books on turbomachines, but you may go around and see if you prefer to use them instead of the original English books.

Course Evaluation:

The students are evaluated through a number of assignments, short term projects, and final term examination (each out of 100) as shown below:

Mark = $\frac{1}{5}$ M

M= 0.7 (Final) + 0.1 (Assignments) + 0.2 (Short term projects)

Term projects, which might be group projects, are introduced during the class discussions. Students should submit professionally-written reports and some of the projects might be presented in the class as well. Only projects which are chosen for the presentation might get 4 marks out of 4.

The final exam has two parts. Part 1 (usually between 30 to 45 minutes) is closed book and students have to answer questions and derive some formulas or solve some simple problems. In Part 2 of the exam (about 100 minutes) students have to solve some problems and they are allowed to use their class notes or any other book or document.