INTRODUCTION TO TURBOMACHINERY

PROF. SUBRATA SARKAR
Department of Mechanical Engineering
IIT Kanpur

TYPE OF COURSE : New | Core | UG/PG
COURSE DURATION : 12 Weeks (26-Jul' 21 - 15-Oct' 21)
EXAM DATE : 24 Oct 2021

PRE-REQUISITES : Basic Thermodynamics and Fluid Mechanics

INTENDED AUDIENCE : UG/PG students, research scholars, and practicing engineers interested in the field of turbomachinery.

INDUSTRIES APPLICABLE TO : HAL/GTRE/NTPC/NHPC/BHEL/GE India etc

COURSE OUTLINE :

The objective of the course is to provide a framework to discuss different kinds of turbomachinery through a unified approach. The material presented is intended for undergraduate and graduate students apart from professional engineers in the industry engaged in the analysis and development of turbomachinery. Coverage begins with the fundamental concepts, the equations of motion in a rotating system, and the Euler equation for turbomachinery. This is followed by the gas turbine cycle, similarity rules, and cascade flow analysis. The reader is then focused on flows through compressors and turbines, including a brief discussion on the secondary flow, tip clearance, blade cooling, surge, and stall. The course will be concluded with a discussion on CFD in the design and analysis of turbomachinery.

ABOUT INSTRUCTOR :

S. Sarkar, Professor of the Department of Mechanical Engineering at the Indian Institute of Technology Kanpur, India, HAL Chair, Convener of Energy Conversion and Computational Turbomachinery Laboratories, received Ph.D. in 1995. He also severed the University of Surrey, UK for two years. Dr. Sarkar is involved in research over the last 25 years and contributed significantly to the fields of Fluid Mechanics, Turbulence, Turbomachinery, CFD, and Large-Eddy Simulation. He is the author of several peer-reviewed technical papers in international journals and conferences, and has guided a number of masters and doctoral students. He has completed many industrial and sponsored projects. He has served as a technical expert on project-review committees of national importance, and also served on numerous academic and administrative committees of the Institute.

COURSE PLAN :

1. Introduction and Classification: Axial flow, radial flow and mixed flow machines, the equations of motion in rotating frame of reference, effects of Coriolis and Centrifugal forces, momentum and energy equation, Euler work, and illustrative examples.[5]

2. Gas Turbine Cycle: Brayton Cycle, regenerative cycle, reheat, inter-cooling, turboprop, turbojet and turbofan engine, thrust augmentation, and illustrative examples. [4]

3. Similarity Analysis: Similarity rules, specific speed, Cordier diagram and illustrative examples.[4]

4. Cascade Analysis: Two-dimensional cascade theory, lift and drag, blade efficiency, estimation of loss, compressor and turbine cascade, blade geometry, and illustrative examples.[5]

5. Axial Flow Compressor: Two-dimensional pitch line design and analysis, h-s diagram, degree of reaction, the effect of Mach number, performance and efficiency, three-dimensional flow, tip clearance, losses, compressor performance, and illustrative examples. [6]

6. Centrifugal Pump and Compressor: Theoretical analysis and design, the effect of circulation and Coriolis forces, reversal eddies, slip factor, head and efficiency, diffuser, introduction to the combustion system, and illustrative examples.[6]

7. Axial Flow Turbine: Two-dimensional pitch line design, stage loading capacity, degree of reaction, stage efficiency, turbine performance, blade cooling, and illustrative examples.[6]

8. CFD Applied to Turbomachinery Flows: Governing equations, numerical methods, and test cases illustrating flow and heat transfer related to turbomachines.

Total Class: 36 (It equivalent to 12 weeks considering 3 classes per week)