

Workshop on Advances in Aerodynamic Design of Turbines and Mixed Flow Compressors

Date: Tuesday, November 7th, 2017 **Location:** Aerospace Faculty Auditorium
Time: 08:30-17:30

The training activities will be open for all students, industry and academic staff. There is no cost for registration; however it is mandatory for all participants. Please reserve your spot until 01/11/2017 by contacting Vered Seginer <veredseg@ae.technion.ac.il>, with subject line "Turbomachinery Workshop Registration 2017", indicating the full name of all participants.

Program

- ❖ 08:30 - 09:00 Registration and Introduction, Light Refreshments

- ❖ 09:00 - 10:10 Turbine Aerodynamic Design Process Dr. John Clark
 - Iterative design loop, example for single stage, high pressure turbine
 - Meanline design to meet cycle requirements
 - 2D profile design
 - 3D stacking and steady Navier-Stokes analysis
 - Unsteady Navier-Stokes analysis
- ❖ 10:10 - 10:20 Coffee Break
- ❖ 10:20 - 11:20 Component Design for Reduced Unsteadiness, Part I
 - Desiderata for success
 - Code validation of a baseline design
 - Profile design for reduced shock strength and airfoil-row interaction
- ❖ 11:20 - 11:30 Coffee Break
- ❖ 11:30 - 12:45 Component Design for Reduced Unsteadiness, Part II
 - 3D airfoil optimization through genetic algorithm and unsteady RANS simulations
 - Experimental verification of the airfoil row and asymmetry effects on unsteadiness
 - Opportunities arising from manufacturing variability
- ❖ 12:45 - 13:30 Break (Light Lunch will be served)

- ❖ 13:30 - 14:00 Introduction to Mixed Flow Compressor Mr. Abdul Nassar
 - Application of mixed flow compressor
 - Stage configurations and selections
 - Loss models for mixed flow compressors
- ❖ 14:00 - 14:50 Introduction to AxSTREAM™ Platform for Turbomachinery Design
 - ·AxSTREAM™ architecture
 - ·Modules and its interactions
 - ·Different solvers in AxSTREAM™
- ❖ 14:50 - 15:00 Coffee Break

- ❖ 15:00 - 15:50 Designing from Specification
 - Designing mixed flow compressor from specification in AxSTREAM™
 - Meanline calculation and full streamline calculation
 - Off-design performance map generation
- ❖ 15:50 - 16:20 Profiling and 3D Blade Design
 - Section profiling and features
 - Flow analysis - blade-to-blade, axi-symmetric and full CFD
- ❖ 16:20 - 16:30 Coffee Break
- ❖ 16:30 - 16:45 Structural Analysis and 3D blade design
 - Stress and modal analysis
 - Campbell diagram and interference diagram calculation
 - Rotordynamic analysis of mixed flow compressor
- ❖ 16:45 - 17:30 Integration and optimization
 - Optimization tasks
 - Integrating multiple modules for optimization
 - Performing off-design calculation using integrated approach for direct calculation for a gas turbine application.

Bios:

Dr. John Clark

Dr. John Clark is the Principal Engineer and Lead Researcher in Turbines for the Turbine Engine Division in the Aerospace Systems Directorate at the Air Force Research Laboratory (Wright-Patterson Air Force Base, Dayton, OH, USA). He was awarded the degree of Doctor of Philosophy from the University of Oxford where he was a student of Prof. Terry Jones at the Osney Turbomachinery Laboratory. Subsequent to his graduate education he worked at United Technologies, Pratt & Whitney in the Turbine Aerodynamics group. From there he joined the Air Force Research Laboratory in 2002. Dr. Clark has more than 70 journal publications and refereed conference papers on the topics of unsteady aerodynamics in turbomachines, high- and low-pressure turbine aerodynamics, turbine design methods and applications, optimization of turbine components, boundary-layer transition modeling, and turbine heat transfer and cooling. These efforts have so far generated 4 US patents and one pending. Since 2013 Dr. Clark has served as Associate Editor of the ASME Journal of Turbomachinery. Also, in 2012 he was selected by the American Institute of Aeronautics and Astronautics as the Engineer of the Year in part for his efforts to improve the understanding of unsteady shock interactions in turbines.

Mr. Abdul Nassar

Mr. Abdul Nassar is currently the Managing Director of SoftInWay Turbomachinery Solutions Pvt. Ltd., a sister concern of SoftInWay, the global engineering company offering turbomachinery solutions. He is also the Technical Director for Asia and Middle East. He has about 22 years of experience in the industry and academia. He started his career as a steam turbine maintenance engineer. Prior to joining SoftInWay, he was working as an assistant professor at M. S. Ramaiah School of Advanced Studies teaching turbomachinery and aerodynamics. He has guided more than 35 students in their Masters' projects and has 24 technical publications in various journals and conference proceedings. His main areas of interest are turbomachinery design, aerodynamics and thermodynamics.