Preface

Hypersonic systems will provide a revolution in commercial transport, space access, and military missions. This RTO Lecture Series provides clear engineering guidelines based on research carried out in USA, Europe, Australia, Japan and Russia. Following the keynote lecture, turbine-based cycles are introduced, including variable cycles. A rocket-ramjet combined cycle engine is then proposed. A lecture on detonation propulsion focuses on fundamental properties; various design concepts with their theoretical and measured performances.

The second chapter demonstrates the design process of a ramjet intake through a design example for Mach 4 to 6. The next lecture presents engineering models of the aerodynamics and propulsion to evaluate the cruise flight performance of future long range missiles with special attention to vehicle-engine integration. The third note addresses the combined thermal loading due to the aerodynamic heating as well as reactive gas dynamics from the propulsion unit. Thermal equilibrium conditions of the structural parts are evaluated with and without active cooling. The fourth note is dedicated to the specific design of the scramjet intakes.

The third chapter will be dedicated to scramjets and dual mode operation. The first note presents design rules on the isolator and nozzle, in particular to the estimation of the heat loads on a scramjet or a dual-mode ramjet. Solutions to sustain such high energy will be proposed and how to combine materials, cooling techniques and system requirements.

The final chapter starts with the overall system analysis of scramjets, considering what is the optimum number of engine modules; comparison between fixed or movable geometry; effect of engine mass and size to on-trajectory-performance of an air-breathing space launcher. The second note presents an overview on EU funded research programs. The third note presents the major achievements and lessons learned from the Sanger II project, with emphasis on the selection of the combined cycle engine, propulsion operational modes. The last note will review the LEA program and its contributions to address key technologies considering potential future extensions.

Prof. G. Paniagua & Prof. J. Steelant
Lecture Series Editors
von Kármán Institute, Belgium & European Space Agency
ESTEC
Netherlands