



Advanced Propulsion

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Syllabus

References

Books

- 1- Element of Propulsion, Gas turbine and rockets, J. Mattingly, AIAA Education Series, 2006, ISBN-10: 1-56347-779-3.
- 2- Mechanics and Thermodynamics of Propulsion, P. Hill and C.R. Peterson, Prentice Hall, 1991, ISBN: 0201146592.
- 3- Aircraft Propulsion, S. Farokhi, Wiley, 1st Edition, 2009, ISBN 978-0-470-03906-9.
- 4- Modern Compressible Flow with Historical Perspective, J. Anderson, McGrawHill, 2002, ISBN10: 0072424435.
- 5- Hypersonic Airbreathing Propulsion, by: Heiser, W.H., Pratt, D. T., AIAA Education Series, 1994, ISBN 978-1-56347-035-6.

Review Papers

- 1- Shock train and pseudo-shock phenomena in internal gas flows, Kazuyasu Matsuo, Yoshiaki Miyazato, Heuy-Dong Kim, Progress in Aerospace Sciences, Vol. 35, pp. 33-100, 1999.
- 2- Fluid Phenomena in scramjet combustion systems, E.T. Curran, Heiser, W.H., Pratt, D. T., Ann. Rev. of Fluid Mechanics, Vol. 28, pp. 323-360, 1996.

Topics

1- Overview of Propulsion (Mattingly: Chapter 1)

- 1-1 Operational Envelopes, Standard Atmosphere
- 1-2 Air-breathing Engines overview
- 1-3 Aircraft Performance
- 1-4 Rocket Engines

2- Review of Gas Dynamics (Anderson: Chapters 3-4, Farokhi: Chapter 2)

- 2-1 H-K Diagram
- 2-2 Normal shock wave
- 2-3 Flow with heat addition
- 2-4 Flow with friction

3- Gas Turbine Engine (Mattingly: Chapter 4-5, Hill-Peterson: Chapter 5, Farokhi: Chapter 4)

- 3-1 Gas Turbine Engine Components,
- 3-2 Brayton Cycle
- 3-3 Specific Thrust, Specific Fuel Consumption, Specific Impulse, Fuel/Air Ratio
- 3-4 Thermal Efficiency, Propulsive Efficiency, Overall efficiency
- 3-5 Ideal Engine design
- 3-6 Airbreathing Engine Performance Measures
- 3-7 Ramjet
- 3-8 Turbojet
- 3-9 Turbofan
- 3-10 Real Engine design
- 3-11 Ramjet
- 3-12 Turbojet
- 3-13 Turbofan
- 3-14 Optimum working conditions for Gas Turbine Engine components
- 3-15 Engine-Aircraft matching

4-Aerothermodynamics of Inlets, Combustors and Nozzles (Hill-Peterson: Chapter 6, Farokhi: Chapter 5)

- 4-1 subsonic inlets
- 4-2 supersonic inlets and start-up process
- 4-3 Combustion chambers
- 4-4 Afterburners and ramjet combustors
- 4-5 Exhaust nozzles

5- Advanced topics in Gas Dynamics (Papers 1)

- 5-1 Irregular Mach Reflection
- 5-2 Shock wave/boundary layer interaction
- 5-3 Shock Polar
- 5-4 Mach Train Analysis
- 5-5 Analytical Relations for Mach Train

6- Scramjet Propulsion- Part1 (Papers 2)

- 6-1 Practical Progress
- 6-2 Heat addition in duct with Area variations
- 6-3 Isolators
- 6-4 Aerothermodynamics of dual mode combustion system
- 6-5 Real H-K diagram
- 6-6 Interoperation of Experimental Data
- 6-7 Fuel-air mixing processes
- 6-8 Measures of local goodness of mixing
- 6-9 Mixing in a Turbulent shear layer

7- Scramjet Propulsion-Part2 (Heiser and Pratt, Ch. 3-4)

- 7-1 Hypersonic Airbreathing Engine Performance Analysis
- 7-2 Thermodynamics Closed Cycle Analysis
- 7-3 Maximum Allowable Compression Temperature
- 7-4 Required Burner Entry Mach Number
- 7-5 First Law Analysis
- 7-6 Thermodynamics Process Assumptions
- 7-7 Thermodynamics Process Analyses
- 7-8 First Law Analysis Results
- 7-9 Stream Thrust Analysis
- 7-10 Compression Components
- 7-11 Typical Compression Components Configurations
- 7-12 Compression Components Analysis Overview
- 7-13 Influence of Boundary Layer Friction
- 7-14 Burner Entry Pressure
- 7-15 Leading-Edge Oblique Shock Wave Geometry

8- Special Topics: Micropropulsion (Handouts)

- 8-1 Introduction to Microfluidics
- 8-2 Slip/Jump Boundary condition: General forms and Physical background
- 8-3 Slip/Jump Boundary condition: Numerical Implementation
- 8-4 Slip/Jump Boundary condition: Maxwell model vs. Langmuir model
- 8-5 Introduction to Micropropulsion
- 8-6 Paper Review for numerical simulation