Fundamentals of Compressible Aerodynamics

Code	Credit Hours
AE-216	3-0

COURSE DESCRIPTION:

The goal of this course is to lay out the fundamental concepts of the compressible flow of gases. It starts with the governing equations, thermodynamic context and characteristic parameters. Topics to be covered include propagation of disturbances, isentropic flows, normal shock wave relations, oblique shock waves, compressible flows in ducts with area changes, friction and heat addition, heat transfer to high-speed flows, steady 2D supersonic flow, Prandtl-Meyer Function, etc. It will also include basic analysis of linearizing non-linear equations using the Linearized Flow Theory and introduce the students to the Method of Characteristics methodology to fundamentally evaluate a variety of internal and external flows. Introduction to Hypersonic Flow is also taught in the last part of the course.

TEXT AND MATERIAL

Textbook:

1. Introduction to Compressible Fluid Flow by Patrick H. Oosthuizen & William E. Carscallen,CRC Press Latest Available Edition
2. TURBINE AEROPLANE STRUCTURES AND SYSTEMS by Aviation Maintenance Technician Certification Series, Latest Available Edition

References Material:

1. "Modern Compressible Flow with Historical Perspective" by John D. Anderson, McGraw-Hill, NY, 3rd edition, 2003.
2. "Gas Dynamics" by James E. A. John & Theo G. Keith, Pearson Prentice Hall, NJ, 3rd Edition, 2006.
3. "The Dynamics and Thermodynamics of Compressible Fluid Flow", Shapiro, Ascher H, John Wiley & Sons, 1st Edition, 1953.

PREREQUISITE:

Incompressible Aerodynamics
Engineering Thermodynamics

ASSESSMENT SYSTEM:

Quizzes	10-15%
Assignments	5-10%
Mid Terms	30-40%

ESE	40-50%

TOPICS COVERED

Week No	Description	Ref
1	Introduction to Compressible Fluid Flow Conservation Laws, Equation of Steady 1-D Compressible Fluid Flow	1.1-2, 1.4 Text 1 2.1-8 Text 1
2	Some Fundamental Aspects of Compressible Flow, Wave propagation and Speed of Sound	3.1-4 Text 1 Ref 3, 5.6 - 5.10
3	Pressure Coefficient, obtaining lift from pressure coefficient, compressibility correction, critical Mach No and drag divergence Wave Drag and Summary of Airfoil Drag	Ref 3, 5.6 - 5.10 Text 2, 5.11-5.12
4	1D Isentropic Flow, Normal Shock Waves	4.1-4 Text 1 5.1-7 Text 1
5	Oblique Shock Waves	6.1-4 Text 1
6	Prandtl Meyer Expansion Fan	7.1-3 Text 1
7	Variable Area Isentropic Flow	8.1-5 Text 1
8	Applications Converging Diverging Nozzles Supersonic Airfoils (Lift and Drag calculation)	7.4 & 8.5 8.6 & 4.4 8.7 & 8.2

		8.3-4 Text 2
9	**MID TERM EXAM**	
10	1D Steady Adiabatic Flow in a Duct with Friction (Fanno Line flow)	9.1,9.2,9.4-6 Text 1
11	1D Steady Flow with Heat Addition or Removal in a Duct (Rayleigh Line flow)	10.1,10.5-10 Text 1
12	Supersonic Diffusers Exit flow for Nozzles and Plug Nozzles Aircraft Engine Intakes	7.4 & 8.5 8.6 & 4.4 8.7 & 8.2 8.3-4 Text 2
13-14	Introduction to Linearized Flow	14.5-7 & Ch 13 of Text 2
15	**Introduction to Methods ofCharacteristics** Supersonic rotational flow Internal flow	11.2 & 11.3 of Ref 1
16	**Introduction to Hypersonic Flow**Newtonian Flow Theory Boltzmann equation Hypersonic Vehicle design considerationHigh Temperature flows	11.1-5 & Ch 15 of Text 2
17	Revision	
18	**END SEMESTER EXAMINATION**	