COMPRESSIBLE AERODYNAMICS

ENAS 365

Lecture	**: 3**	**Year : III**
Tutorial	**: 2**	**Part : II**
Practical	**: 1**	

Course Objectives:

The objective of this course is to provide a solid foundation in compressible aerodynamics. Students will learn the significance of compressibility in flows, understand shock and expansion waves, derive key flow equations, and apply computational methods in practical sessions to solve compressible flow problems.

1 Basic Aerothermodynamics (3 hours)

- 1.1 Definitions and historical development
- 1.2 Speed of sound and mach number
- 1.3 Existence of shock waves
- 1.4 Effects of compressibility on flight vehicles
- 1.5 Aerothermodynamic of high-speed flight

2 Compressible Flows (12 hours)

- 2.1 Review of thermodynamics
- 2.2 Internal energy and enthalpy
- 2.3 Isentropic relations
- 2.4 Definition of compressibility
- 2.5 Governing equations for inviscid, compressible flow
- 2.6 Definition of total (Stagnation) conditions
- 2.7 Subsonic versus supersonic compressible flows

3 Shock Waves (16 hours)

- 3.1 Derivation of normal shock relations
- 3.2 Calculation of normal shock wave properties
- 3.3 Measurement of velocity in a compressible flow
- 3.4 Derivation of oblique shock relations
- 3.5 Calculation of oblique shock wave properties
- 3.6 Prandtl-Meyer expansion waves
- 3.7 Shock-expansion theory

4 Internal Compressible Flows (8 hours)

- 4.1 Examples: Gas turbines to ramjets
- 4.2 Diffusers

4.3 Nozzles
4.4 Supersonic tunnels
4.5 The area rule

5 External Compressible Flows (6 hours)

5.1 Flow over a sphere
5.2 The velocity potential equation
5.3 Prandtl-Glauert compressibility correction
5.4 Critical and drag divergence mach numbers

Tutorial (30 hours)

1. Calculations of compressible inviscid flow parameters
2. Derivation and calculation of normal shock properties
3. Derivation and calculation of oblique shock properties
4. Calculation of expansion wave properties

Practical (15 hours)

1. Model the normal and oblique shock relations and develop an understanding of the theta-beta-M plot and visualize the compressible flows using the Schlieren technique
2. Isentropic flow in a convergent-divergent (C-D) nozzle

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	3	2
2	12	16
3	16	20
4	8	12
5	6	8
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Anderson, J. D., Jr. (1991). Fundamentals of aerodynamics (Latest Edition). McGraw-Hill.
2. Anderson, J.D. (1990). Modern compressible flow: With historical perspective (Latest Edition). McGraw-Hill.
3. Ames, F.E., Tang, C.C. (2021). An introduction to compressible flow. CRC Press.
4. Zucker, R. D., Biblarz, O. (2019). Fundamentals of gas dynamics. John Wiley & Sons.

FUNDAMENTALS OF INTERNATIONAL AVIATION

ENAS 366

Lecture	**: 3**	**Year : III**
Tutorial	**: 2**	**Part : II**
Practical	**: 1**	

Course Objectives:

The objective of this course is to provide students with a comprehensive understanding of aviation law, aircraft, operations, navigation, aerodromes, security, environment, safety, accidents, and Remotely Piloted Aircraft Systems (RPAS). Students will learn international and national regulations, operational practices, safety and security measures, environmental impacts, and RPAS integration, preparing them for professional roles in aviation management and operations.

1 Air Law **(4 hours)**

- 1.1 Origin and history of aviation
- 1.2 ICAO conventions
- 1.3 ICAO structure
- 1.4 National and international aviation regulations

2 Aircraft **(5 hours)**

- 2.1 Aircraft categories
- 2.2 Flight basics
- 2.3 Aircraft engine basics
- 2.4 International regulations for airworthiness and operations
- 2.5 Roles and working environment of aviation maintenance personnel

3 Operations **(4 hours)**

- 3.1 International regulation for operations
- 3.2 Aviation professional training and license
- 3.3 Aviation operations categories
- 3.4 Dangerous good transportations

4 Navigations **(4 hours)**

- 4.1 Air traffic management
- 4.2 Role of ATC
- 4.3 Communications, navigations and surveillance
- 4.4 Future of air traffic management

5 Aerodrome **(4 hours)**

5.1 Introduction and history of airports
5.2 Role of airport council international
5.3 International regulation
5.4 Organization structure

6 Security **(6 hours)**

6.1 ICAO Annex-17
6.2 International conventions for security
6.3 Security measures
6.4 Acts of unlawful interference
6.5 Criminal activities in aviation
6.6 Terrorist attack- Consequences
6.7 Modern security initiative
6.8 Universal security audit program

7 Environment **(5 hours)**

7.1 ICAO Annex- 16
7.2 Meteorology and climate change impact on aviation
7.3 ICAO initiative and CORSIA
7.4 Weather Information disseminations
7.5 Aircraft emissions and noise

8 Accidents **(5 hours)**

8.1 Accident rate
8.2 Search and rescue
8.3 Accident and incident
8.4 Accident investigations and its casual factors

9 Safety **(4 hours)**

9.1 ICAO Annex- 19
9.2 Safety management system
9.3 Human factor in aviation

10 Remotely Piloted Aircraft Systems **(4 hours)**

10.1 Origin and history of RPAS
10.2 RPAS market
10.3 Integration of RPAS with traditional aviation regulations
10.4 Various factors considerations for RPAS

Tutorial **(30 hours)**

1. Case study – 9/11 and Aviation Security Breach – Nepal
2. Case Study – Air France and Biman Bangladesh Accidents

3. Case Study – Importance of Navigation (Tenerife airport disaster)
4. SHELL Model

Practical **(15 hours)**

1. Application of accident causation model
2. Emergency response preparedness drill
3. Visit of international airline office

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	4	6
2	5	6
3	4	6
4	4	6
5	4	6
6	6	6
7	5	6
8	5	6
9	4	6
10	4	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Kearns, S. (2018). Fundamentals of international aviation. London, England: Routledge, Taylor & Francis Group.
2. Havel, B. F., Sanchez, G. S. (2014). The principles and practice of international aviation law. Cambridge, England: Cambridge University Press.
3. International Civil Aviation Organization. (2025). ICAO Annexes to the Convention on International Civil Aviation (19 technical annexes). International Civil Aviation Organization.
4. Abeyratne, R. (2014). Aviation and climate change: In search of a global market-based measure. New York, NY: Springer.
5. Dalamagkidis, K., Pieg, L. A., Vachtsevanos, G. J. (2012). On integrating unmanned aircraft systems into the national airspace system: Issues, challenges, operational restrictions, certification, and recommendations (2nd ed.). London, England: Springer.