Principles of Fluid Dynamics - Web course

NPTEL

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Aerospace Engineering

COURSE OUTLINE

"Fluid Dynamics" deals with the study of fluids while in motion. Both gases and liquids are classified as fluids and their applications are enormous. This is a very important subject in many engineering disciplines. With respect to under graduate syllabus in "Aerospace Engineering", the course contents have been designed such that the students get familiar with fundamental aspects, governing equations of fluid flow and their application to simple flow problems. The subjects coved in this course gives introduction to various "Aerospace Engineering" courses such as aerodynamics, gas dynamics and aero-testing facilities. Further attempts have been made to familiarize the students about various fluid flow measurement techniques and experimental aerodynamics. The WEB course materials matter will be very useful to undergraduate students and practicing teachers.

Contents: Basic Concepts and Fundamentals, Governing Equations of Fluid Motion, Inviscid Incompressible Flows, Viscous Incompressible Flows, Compressible Flows, Flow Measurement Techniques and Introduction to Aero Testing Facilities.

COURSE DETAIL

Module	Topic	No. of Hours
1. Basic Concepts and Fundamentals	Definition and properties of Fluids, Introduction to fluid statics and kinematics	02
2. Governing Equations of Fluid Motion	Langragian and Eulerian description, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler's equation, Bernoulli's Equation	07
3. Inviscid Incompressible Flows	Stream function and Velocity potential function, Circulation, Line vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Robins and Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag	08
4. Compressible Flows	Speed of sound and Mach number, Basic equations for one dimensional flows, Isentropic relations, Normal-shock wave, Oblique shock wave, Prandtl-Meyer expansion waves, Fundamentals of hypersonic flows, Mach number independence, Compressible viscous flows, Compressible boundary layers	08
5. Viscous Incompressible Flows	Couette flows, Poiseuille flows, Creeping flows, Concepts of boundary layer and flow separation	11
6. Dimensional Analysis	Introduction to dimensional parameters, Buckingham pi theorem, Non-dimensional parameter in fluid mechanics, Modeling and similitude, Flow similarity, Models and prototype, Distorted model	02

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7. Flow Measurement Techniques	Measurements Temperature, Pressure Measurements: Pressure transducers, pitot tube, pressure sensitive paints, Velocity/Discharge measurements: Orifice meter, Venturiemeter, Anemometer, Force Measurements: Strain gauges force balances, Flow Visualization: PIV, Schlieren technique	07
8. Aero Testing Facilities	Closed and open circuit wind tunnels, Supersonic wind tunnels, Shock tunnels, Miscellaneous Facilities	02

References:

1. Fox W. Robert, McDonald T. Alan, Introduction to Fluid Mechanics, Fourth Edition, John Wiley & Sons, 1995.
2. Frank M. White, Fluid Mechanics, Tata McGraw-Hill, Singapore, Sixth Edition, 2008.
3. Frank M. White, Viscous Fluid Flow, Third Edition, McGraw-Hill Series of Mechanical Engineering, 2006.
4. Goldstein J. Richard, Fluid Mechanics Measurements, Second Edition, Taylor & Francis Publication, 1996.
5. John D. Anderson Jr, Modern Compressible Flow with Historical Perspective, McGraw-Hill, 1990.
6. John D. Anderson Jr., Fundamentals of Aerodynamics, McGrawHill, 2005.
7. John D. Anderson Jr., Hypersonic and High Temperature Gas Dynamics, McGraw-Hill, 1989.
8. Pope A and Kennith L.G., High-Speed Wind Tunnel Testing, John Wiley & Sons, 1965.
9. Rae W.H. and Pope A, Low-Speed Wind Tunnel Testing, John Wiley & Sons, 1984.
10. Schlichting H., Boundary Layer Theory, Springer Verlag, 2000.