COURSE CODE	COURSE TITLE	L	T	P	C
1151AE107	INCOMPRESSIBLE FLOW AERODYNAMICS	3	0	0	3

Course Category:

Programme core

a. Preamble :

The primary objective of this course is to teach students how to determine aerodynamic lift and drag over an airfoil and wing at incompressible flow regime by analytical methods.

b. Prerequisite Courses:

- Fluid Mechanics

c. Related Courses:

- Airplane Performance
- Compressible flow Aerodynamics
- Aero elasticity
- Flapping wing dynamics
- Industrial aerodynamics
- Transonic Aerodynamics

d. Course Educational Objectives:

- To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
- To make the student understand the concept of vorticity, irrotationality, theory of air foils and wing sections.
- To introduce the basics of viscous flow.

e. Course Outcomes:

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Apply the physical principles to formulate the governing aerodynamics equations	K3
CO2	Find the solution for two dimensional incompressible inviscid flows	K3
CO3	Apply conformal transformation to find the solution for flow over airfoils and also find the solutions using classical thin airfoil theory	K3
CO4	Apply Prandtl's lifting-line theory to find the aerodynamic characteristics of finite wing	K3
CO5	Find the solution for incompressible flow over a flat plate using viscous flow concepts	K3

f. Correlation of COs with POs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L		H		L	M	H		H		
CO2	H	L		H		L	M	H		H		
CO3	H	L		H		L	M	H		H		

CO4	**H**	**L**		**H**		**L**	**M**	**H**		**H**		
CO5	**H**	**L**		**H**		**L**	**M**	**H**		**H**		

H- High; M-Medium; L-Low

g. Course Contents:

UNIT-I INTRODUCTION TO LOW SPEED FLOW **L-9**

Models of the fluid: control volumes and fluid elements. Continuity, Momentum and energy equations. Substantial derivative, Vorticity and circulation, stream function, irrotational flow, velocity potential, Euler equation, incompressible Bernoulli's equation.

UNIT-IITWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW **L-9**

Laplace Equation, Elementary flows and their combinations, Ideal Flow over a circular cylinder, Alembert's paradox, Magnus effect, Kutta joukowski's theorem, real flow over smooth and rough cylinder

UNIT-III AIRFOIL THEORY **L-9**

Cauchy-Riemann relations, complex potential, methodology of conformal transformation, Kutta-Joukowski transformation and its applications, Kutta condition, kelvin'scirculation theorem, starting vortex, thin airfoil theory and its applications.

UNIT-IV WING THEORY **L-9**

Vortex filament, Biot-savart law, Helmholtz Theorems bound vortex and trailing vortex, horse shoe vortex, lifting line theory and its limitations.

UNIT-V VISCOUS FLOW **L-9**

Newton's law of viscosity, Boundary Layer, Navier-Stokes equation, displacement, Momentum thickness, Flow over a flat plate, Blasius solution.

Total Periods: 45

h. Learning Resources

i. Text Books:

1. Houghton, E.L., and Carruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989
2. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 2010.
3. Bertin J.J., and Russell M. Cummings., "Aerodynamics for Engineers" 6th edition, Prentice-Hall,2013

ii. References:

1. Clancy, L.J., "Aerodynamics", Pitman, 5th Edition.
2. Houghton, E.L., and P. W. Carpenter., "Aerodynamics for Engineering students", 6th Edition, Butterworth-Heinemann, 2012.
3. Tapan K. Sengupta, "Theoretical and Computational Aerodynamics", 1st edition, Wiley 2014
4. Radhakrishnan.E, "Theoretical Aerodynamics", John Wiley & Sons, 2013
5. Karamcheti K., (1966), Principles of Ideal-Fluid Aerodynamics, John Wiley & Sons Inc.
6. Kuethe A. M. and Chow C.-Y., (1986), "Foundations of Aerodynamics: Bases of Aerodynamic Design" Wiley India, 2009
7. Kundu P.K. & Cohen I.M., (2008), Fluid Mechanics, Elsevier Inc.
8. Milne Thomson, L.H., "Theoretical aerodynamics", Macmillan, 1985.
9. Ion Paraschivoiu, "SubsonicAerodynamics", Pressesinternationals Polytechnique,2003