COURSE CONTENT

AERODYNAMICS FOR PRACTICAL APPLICATIONS								
I Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BAEE01	Core	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Aerodynamics								

I. COURSE OVERVIEW:

This course is intended to provide advance concepts to aerodynamics of the flight vehicle and research topics. This covers the incompressible and compressible flows along with different computational methods related to panel method used for industrial purposes.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The physics behind the aerodynamic flows used for flight vehicles.
II. The viscous effects in the aircrafts and related systems.
III. The different computational modeling techniques used for simulation systems.
IV. The different wind tunnel experimentation techniques to measure the flow pattern of the model

III. COURSE OUTCOMES:

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

CO 1 Relate the physics of the aerodynamic flow for predicting aerodynamics characteristics.

CO 2 Demonstrate viscous effects of the aerodynamic flows by using Lifting Line theory, Lifting Surface theory.

CO 3 Illustrate the boundary layer theory by using governing equations for getting drag of the system.

CO 4 Analyze the relations between choices made early in the turbo machinery design process and the final components and operability.

CO 5 Apply the Euler's equations for turbo machinery to analyze energy transfer in turbo machines

CO 6 Analyze the aerodynamic performance of air vehicle by using the wind tunnel techniques.

IV. COURSE CONTENT:

MODULE-I: PHYSICS OF AERODYNAMIC FLOW AND FLOW MODELING (09)

Physics of Aerodynamic flows: Atmospheric properties, conservation laws, conservation equations, units and parameters, adiabatic flows, Isentropic flows. Low speed and Incompressible flows, Vorticity transport and irrationality.

Flow Field Modeling: Aerodynamic modeling, Vorticity and Source Lumping, 3D Vortex Sheet Strength Divergence Constraints, Equivalence of Vortex and Doublets Sheets. Velocity Potential Integrals, Flow Field Modeling with Source and Vortex Sheets, 2D Far Field Approximation. 3D Far Fields, Approximation.

MODULE-II: VISCOUS EFFECT IN AERODYNAMIC FLOW (09)

Inviscid Flow Model, Displacement Effect, Improved Inviscid Flow Model, Viscous De cambering Stall Mechanism, and Consideration in Flow Model Selection. Lifting Line theory, Lifting Surface theory, Vortex lattice Method

MODULE-III: BOUNDARY LAYER ANALYSIS (09)

Boundary layer flow features, Defect Integrals and thickness, Boundary layer Governing equations, Boundary layer response to pressure and shear gradient, Integral boundary layer relations, Self-Similar boundary layers.

Axisymmetric boundary layers, 3D boundary layers, 2D Boundary layer solution methods, Integral boundary layer solution, Coupling of potential flow and boundary layers, profile drag prediction, Transition and types.

MODULE-IV: UNSTEADY & COMPRESSIBLE AERODYNAMIC FLOWS (09)

Unsteady Potential flows, Governing equations for Unsteady Potential Flows, Potential Jump, Unsteady Panel Method, Unsteady 2D Airfoil Effects of compressibility, Compressible flow Quantities, Shock wave and Wave drag, Compressible Potential Flows, Small distance Compressible Flows, Prandtle-Glauert Analysis, Subsonic Compresible Far -Fields, Small Disturbance Supersonic Flows, Transonic Flows,

MODULE-V: NUMERICAL AND EXPERIMENTAL METHODS (09)

Introduction to panel method and its application (Non lifting and Lifting bodies) - Vortex lattice method and its application —Flow past bodies using computational tools - Introduction to CFD. Non-dimensional numbers - Types of similarities – Low speed wind tunnel design parameters - Wind tunnel techniques Estimation of pressure distribution over a finite wing. Estimation of pressure distribution over a finite wing with winglet

V. TEXT BOOKS:

1. Mark D., “Flight Vehicle Aerodynamics”, MIT Press, Cambridge, Massachusetts London, England.
2. Anderson J D, “Modern Compressible Fluid Flow”, Mc-Graw Hill, 2nd edition, 1990.

VI. REFERENCE BOOKS:

1. Rathakrishnan E, “Gas Dynamics”, Prentice-Hall India, 2004.
2. Anderson J D, “Fundamentals of Aerodynamics”, Tata Mc-Graw Hill, 5th edition, 2010

VII. ELECTRONICS RESOURCES:

1. http://rcdata.ir/wpcontent/uploads/2016/10/Mark_Drela_Flight_Vehicle_AerodynamicsBookZZ.org_.pdf
2. www.wind.civil.aau.dk/lecture/8sem_CFD/Lecture1/Lecture1.pdf.
3. personalpages.manchester.ac.uk/staff/david.d.apsley/lectures/comphydr/timedep.pdf

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations