ADVANCED COMPUTATIONAL AERODYNAMICS LABORATORY

I Semester: AE

Course Code	Category	Hours / Expt			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
BAEB09	Core	-	-	4	2	30	70	100
Contact Classes: 36	Tutorial Classes: Nil	Practical Classes: 36				Total Classes: 36		

COURSE OBJECTIVES:

The course should enable the students to:

I. Experience in computing aerodynamic problems and understanding flow physics over the objects
II. Knowledge in estimating flow analysis for different mach numbers.
III. Determining the aerodynamic forces like mainly lift and drag.
IV. Analyze the errors and cause of errors in computational analysis.

COURSE OUTCOMES (COs):

CO 1: Implement the computational fluid dynamic and computational aerodynamic fundamentals by using advanced solvers.
CO 2: Understand the flow properties of flat plate, nozzle and cylinder to demonstrate Reynolds number.
CO 3: Differentiate the flow properties around symmetrical and cambered airfoil.
CO 4: Analyse the coefficient of pressure, lift, drag and moment for different bodies for different flow conditions.
CO 5: Visualize the flow around the different bodies under supersonic conditions.

COURSE LEARNING OUTCOMES (CLOs):

The students should enable to:

1. Understand the behavior of flows around different structured objects.
2. Implement computational aerodynamic fundamentals by using advanced solvers.
3. Explain the usage of modern tools like ICEM-CFD& FLUENT.
4. Understand the flow properties of flat plate to demonstrate Reynolds number.
5. Understand the aerodynamic properties for flow through nozzle.
6. Observe the properties at separation region and wake region of circular cylinder at different Reynolds numbers.
7. Determine the shock wave around the wedge under supersonic conditions
8. Understand the aerodynamic properties of flow over an airfoil.
9. Differentiate the flow properties around symmetrical and cambered airfoil.
10. Observe the shock waves and 3D relieving effect around the cone at supersonic Mach number.
11. Analyze the errors and cause of errors in the computational analysis.
12. Analyze the contours for different bodies for different flow conditions.
13. Understand the aerodynamic properties of flow through diffuser.
14. Visualize the aerodynamic properties though the supersonic intake.

LIST OF EXPERIMENTS	
Week-1	**INTRODUCTION**
Introduction to computational aerodynamics, the major theories, approaches and methodologies used in computational aerodynamics. Applications of computational aerodynamics for classical aerodynamic's problems.	
Week-2	**INTRODUCTION TO ICEM CFD**
Introduction to ICEM CFD, geometry creation, suitable meshing types and boundary conditions.	
Week-3	**INTRODUCTION TO FLUENT**
Introduction to fluent, boundary conditions, solver conditions and post processing results.	
Week-4	**SHOCK WAVE BOUNDARY LAYER INTERSECTION OVER A FLAT PLATE**
Observe the boundary layer phenomena over a flat plate and velocity profile inside the boundary layer.	
Week-5	**SUBSONIC FLOW IN A CONVERGENT DIVERGENT NOZZLE**
Flow through convergent divergent nozzle at different velocities; observe the velocity changes for laminar and turbulent flows.	
Week-6	**CIRCULATION OF THE LIFT OVER A CIRCULAR CYLINDER**
Observe the properties at separation region and wake region over a circular cylinder at different Reynolds numbers.	
Week-7	**PRESSURE DISTRIBUTION OVER A SYMMETRIC AEROFOIL**
Observe flow properties around the flow over a symmetric aerofoil at different velocities and compare the computation results with experimental results (consider the model from aerodynamics laboratory).	
Week-8	**PRESSURE DISTRIBUTION OVER A CAMBERED AEROFOIL**
Observe flow properties around the flow over a cambered aerofoil at different velocities and compare the computation results with experimental results (consider the model from aerodynamics laboratory).	
Week-9	**SHOCK WAVE SUPERSONIC FLOW OVER WEDGE**
Observe the shock wave phenomena and change of properties around a wedge at supersonic Mach number.	
Week-10	**SHOCK WAVE AROUND A CONE**
Observe the shock wave phenomena and change of properties around a cone at supersonic Mach number.	
WeeK-11	**FLOW THROUGH DIFFUSER**
Flow through diffuser at different velocities; observe the velocity changes for laminar and turbulent flows.	
Week-12	**FLOW THROUGH SUPERSONIC INTAKE**
Flow through Supersonic intake at different velocities; observe the velocity changes for laminar and turbulent flows.	
Reference Books:	
1. Anderson, J.D., Jr., Computational Fluid Dynamics the Basics with Applications, McGraw-Hill Inc, 1st Edition 1998. 2. Hoffmann, K. A. and Chiang, S. T., "Computational Fluid Dynamics for Engineers", 4th Edition, Engineering Education Systems (2000). 3. Hirsch, C., "Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics", Vol. I, 2nd Edition, Butterworth-Heinemann (2007).	