COMPUTATIONAL AERODYNAMICS LABORATORY

VI Semester: AE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AAE109	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	3	2	30	70	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 36**				**Total Classes: 36**		

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 LEARNING OUTCOMES (CLOs):

The students should enable to:

1. Understand the behavior of flows around different structured objects.
2. Implement the computational fluid dynamic and 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 circular pipe.
6. Understand the Aerodynamic properties foe flow through cylinder.
7. Observe the properties at separation region and wake region of circular cylinder at different Reynolds numbers
8. Understand the aerodynamic properties of supersonic flow over a wedge
9. Understand the aerodynamic properties of flow over an airfoil.
10. Differentiate the flow properties around symmetrical and cambered airfoil
11. Analyze the errors and cause of errors in the computational analysis.
12. Analyze the coefficient of pressure, lift, drag and moment for different bodies for different flow conditions.
13. Determine the shock wave around cone and wedges for supersonic flow conditions..
14. Observe flow properties and compare the computation results with experimental results
15. Observe the shock waves and 3D relieving effect around the cone at supersonic mach number;
16. Solve the One dimensional wave equation using explicit method of lax equations using finite difference method
17. Solve the One dimensional heat conduction equation using explicit method
18. Generate the Algebraic and Elliptic grids for computational domains.

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 GAMBIT**
Introduction to gambit, 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	**FLOW OVER A FLAT PLATE**
Flow over a flat plate at low Reynolds numbers, observe the boundary layer phenomena, no slip condition and velocity profile inside the boundary layer.	
Week-5	**FLOW THROUGH PIPE**
Flow through pipe at different Reynolds numbers; observe the velocity changes for laminar and turbulent flows.	
Week-6	**FLOW OVER A CIRCULAR CYLINDER**
Flow over a circular cylinder at different Reynolds numbers, observe the properties at separation region and wake region.	
Week-7	**FLOW OVER A CAMBERED AEROFOIL**
Flow over a cambered aerofoil at different velocities, observe flow properties and compare the computation results with experimental results (consider the model from aerodynamics laboratory).	
Week-8	**FLOW OVER A SYMMETRIC AEROFOIL**
Flow over a symmetric aerofoil at different velocities, observe flow properties and compare the computation results with experimental results (consider the model from aerodynamics laboratory).	
Week-9	**FLOW OVER WEDGE**
Flow over wedge body at supersonic mach number; observe the shock wave phenomena and change of properties across the shock wave.	
Week-10	**FLOW OVER A CONE**
Flow over a cone at supersonic mach number; observe the shock waves and 3D relieving effect.	
Week-11	**CODE DEVELOPEMENT**
Solution for the following equations using finite difference method I. One dimensional wave equation using explicit method of lax. II. One dimensional heat conduction equation using explicit method.	
Week-12	**CODE DEVELOPEMENT**
Generation of the following grids I. Algebraic grids. II. Elliptic grids.	

Text Books:

1. J. D. Anderson, Jr., “Computational Fluid Dynamics- The Basics with Applications”, McGrawHill Inc, 2012.
2. D A Anderson, J C Tannehill, R H Pletcher, “Computational Fluid Mechanics and Heat Transfer”, 1st edition, 1997.

Reference Books:

1. Hirsch, C., “Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics”, Vol. I, Butter worth-Heinemann, 2nd edition, 2007.
2. Hoffmann, K. A. and Chiang, S. T., “Computational Fluid Dynamics for Engineers”, Engineering Education Systems, 4th edition, 2000.
3. Patankar, S.V., “Numerical Heat Transfer and Fluid Flow”, Hemisphere Pub. Corporation, 1st edition, 1980.
4. H K Varsteeg, W Malalasekera, “ An Introduction to Computational Fluid Dynamics – The Finite Volume MEthod”, Longman Scientific and Technical, 1st edition, 1995.