B.E Semester: 5 Mechanical Engineering
Subject Name: Advance Fluid Dynamics (ME505-N-D) [Dept. Elect.-1]

A. Course Objective:

- To present a problem oriented in depth knowledge of Advance Fluid Dynamics.
- To address the underlying concepts and methods behind Advance Fluid Dynamics.

B. Teaching / Examination Scheme:

Teaching Scheme				Total Credit	Evaluation Scheme					
L	T	P	Total		Theory		Mid Sem Exam	CIA	Pract.	Total
Hrs	Hrs	Hrs	Hrs		Hrs	Marks	Marks	Marks	Marks	Marks
3	0	2	5	4	3	70	30	20	30	150

C. Detailed Syllabus:

Unit No.	Details
1	**Basic Concepts and Fundamentals:** Definition and properties of Fluids, Fluid as continuum, Langragian and Eulerian description,Velocity and stress field, Fluid statics, Fluid Kinematics.
2	**Governing Equations of Fluid Motion:** Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, NavierStokes equations,Euler's equation,Bernoulli's Equation.
3	**Exact solutions of Navier-Stokes Equations:** Couette flows,Poiseuille flows, Fully developed flows in noncircular cross-sections, Unsteady flows, Creeping flows.
4	**Potential Flows:** Revisit of fluid kinematics,Stream and Velocity potential function, Circulation, Irrotational vortex,Basic plane potential flows: Uniform stream;Source and Sink;Vortex flow, Doublet,Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect;Kutta-Joukowski lift theorem; Concept of lift and drag.
5	**Laminar Boundary Layers:** Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Approximate Methods, Flow separation,Entry flow into a duct.
6	**Elements of Stability Theory:** Concept of small-disturbance stability, Orr-Sommerfeld equation, Inviscid stability theory,Boundary layer stability, Thermal instability, Transition to turbulence.
7	**Turbulent Flow:** Introduction, Fluctuations and timeaveraging, General equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Turbulent pipe flow, Prandtl mixing hypothesis, Turbulence modeling, Free turbulent flows.

8	**Compressible Flows:** Speed of sound and Mach number,Basic equations for one dimensional flows, Isentropic relations, Normal-shock wave, Rankine-Hugoniot relations, Fanno and Rayleigh curve, Mach waves, Oblique shock wave,PrandtlMeyer expansion waves, Quasione dimensional flows, Compressible viscous flows, Compressible boundary layers
9	**Introduction to Computational Fluid Dynamics (CFD):** Boundary conditions,Basic discretization – Finite difference method, Finite volume method and Finite element method.

Total hours (Theory):48
Total hours (Practical):32
Total hours:80

D. Lesson Planning:

Sr. No.	Date/Week	Unit	Weight age	Topic No
1	1^{st} ,2^{nd} ,3^{rd}	Unit 1	20%	1,2
2	4^{th} .5^{th} ,6^{th}	Unit 2	20%	3,4
3	7^{th} , 8^{th} ,9^{th}	Unit 3	20%	5,6
4	10^{th} .11^{th} . 12^{th}	Unit 4	20%	7,8
5	13^{th} , 14^{th} ,$15^{th,}$,16^{th}	Unit 5	20%	9

E. Instructional Method & Pedagogy

1	At the start of course, the course delivery pattern , prerequisite of the subject will be discussed
2	Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal Weight age should be given to all topics while teaching and conduction of all examinations.
3	Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation.
4	One/Two internal exams may be conducted and total/average/best of the same may be converted toequivalent of 30 marks as a part of internal theory evaluation.
5	Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.
6	Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overallinternal evaluation.

F. List of Practical:

1	To study the effect of angle of attack on Lift and Drag force.
2	To study the loss of energy in wake region behind various models (car, jeep, bus etc.) in the wind tunnel.
3	To draw profile of NACA Aerofoils.
4	To visualize and plot the pattern of flow around an object in a fluid stream using Hale-Shaw apparatus.
5	A case study: Performance of real nozzle.
6	To study viscous supersonic flow including compressible boundary layer and compressible turbulent mixing.

7	Measurements of boundary layer thickness using numerical & analytical solution.

G. Students Learning Outcomes:

1	The student can identify different areas of Advance Fluid Dynamics.
2	Can find the applications of all the areas in day to day life.

H. Text Books & Reference Books:

1	Batchelor G.K,An Introduction to Fluid Dynamics, Cambridge University Press, 1983.
2	Fox W. Robert, McDonald T.Alan, Introduction to Fluid Mechanics, Fourth Edition, John Wiley & Sons, 1995.
3	Frank M. White, Fluid Mechanics, Tata McGraw-Hill, Singapore,Sixth Edition, 2008.
4	Frank M. White,Viscous Fluid Flow, Third Edition, McGraw-Hill Series of Mechanical Engineering, 2006.
5	John D.Anderson Jr, Modern Compressible Flow with Historical Perspective, McGraw-Hill, 1990.