SCHEME OF COURSE WORK

Course Details:

Course Title	**: Advanced Fluid Dynamics**	
Course Code	**: 19ME2201 L T P C**	**:3 0 0 3**
Program:	**: M.Tech.**	
Specialization:	**: Thermal Engineering**	
Semester	**: I**	
Prerequisites	**: Basic Fluid Mechanics**	
Courses to which it is a prerequisite		

Course Outcomes (COs):

At the end of the course, the student will be able to

1	analyze and apply the concepts of turbulent flow to solve the fluid flow problems
2	explain the concepts of boundary layer
3	classify the compressible fluid flows and discuss stagnation properties
4	solve nozzle, diffuser, and shock wave problems of compressible fluids
5	apply Prandtl, Rankine-Hugniot equations to solve oblique shock waves and discuss the Fanno curves discuss the Fanno curves

Program Outcomes (POs):	
1	exhibit in-depth knowledge in thermal engineering specialization
2	think critically and analyze complex engineering problems to make creative advances in theory and practice
3	solve problem, think originally and arrive at feasible and optimal solutions with due consideration to public health and safety of environment
4	use research methodologies, techniques and tools, and will contribute to the development of technological knowledge
5	apply appropriate techniques, modern engineering tools to perform modeling of complex engineering problems with knowing the limitations
6	understand group dynamics, contribute to collaborative multidisciplinary scientific research
7	demonstrate knowledge and understanding of engineering and management principles and apply the same with due consideration to economical and financial factors
8	communicate complex engineering problems with the engineering community and society, write and present technical reports effectively

9	engage in life-long learning with a high level of enthusiasm and commitment to improve knowledge and competence continuously
10	exhibit professional and intellectual integrity, ethics of research and scholarship and will realize the responsibility towards the community
11	examine critically the outcomes of actions and make corrective measures

Course Outcome versus **Program Outcomes:**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO-1	S		M								
CO-2		S	M								
CO-3	S	M									
CO-4		S	M								
CO-5	M	S									

S - Strongly correlated, *M* - *Moderately* correlated, *Blank* - *No correlation*

Teaching-Learning and Evaluation

Week	TOPIC / CONTENTS	Course Outcomes	Sample Questions	• Teaching Learning Strategy	Assessment method & Schedule
1	Characteristics of turbulent flow- Reynolds equations of motion-turbulence modelling – Boussineqs Eddy viscosity concept	CO-1	Explain the concept of Boussineqs Eddy viscosity for turbulent flow	• Lecture	
2	Prandtl's mixing length concept – Vonkaman similarity concept – Prandtl's universal velocity distribution	CO-1	ExplainVonkaman similarity concept for turbulent flow	• Lecture • Discussion • Problem solving	
3	Karman –Prandtl velocity distribution power law for velocity in smooth pipes – Friction factor for smooth and rough pipes-Charts for friction factor in pipe flow	CO-2	Derive an expression for the equation of Karman –Prandtl velocity distribution power law for velocity in smooth pipes	• Lecture • Discussion	
4	Navier – Stokes Equations of motion – boundary layer over a flat plate – thickness of boundary layer	CO-2	Discuss formation of boundary layer over a flat plate	• Lecture • Discussion • Problem solving	
5	Prandtl's boundary layer equation – Vonkarmann momentum equations – shear stress and drag	CO-2	Derive Vonkarmann momentum equations for boundary layer	• Lecture • Discussion • Problem solving	**Assignment (week 5-7)**
6	laminar boundary layer – turbulent boundary layer – pressure distribution in	CO-2	Explain about the methods used to control boundary layer separation	• Lecture • Discussion	

	the boundary layer – boundary layer separation				
7	Drag and lift force – lift on an airfoil.	CO-2	Explain about the – lift on an airfoil	• Lecture • Discussion	
8	Wave propagation in an elastic solid medium – propagation of sound waves – Mach number – Mach angle – equation of sound wave. Energy equation – energy equation for non-flow and flow processes	CO-3	Derive an expression for the equation of velocity of sound wave in compressible fluid flow.	• Lecture • Discussion • Problem solving	**Mid-Test 1 (Week 9)**
9	**MID-Test - 1**				
10	adiabatic energy equation – stagnation enthalpy - stagnation temperature - stagnation pressure – stagnation velocity of sound – reference velocities – Bernoulli's equation – effect of Mach number on compressibility.	CO-3	Discuss the effect of Mach number on compressibility	• Lecture • Problem solving	
11	Comparison of isentropic and adiabatic processes – Mach Number variation - expansion in nozzles – compression in diffusers	CO-4	Explain about the expansion and compression in nozzles and diffusers	• Lecture • Discussion • Problem solving	
12	Stagnation and critical states – area ratio as a function of Mach number, impulse function - mass flow rate, flow through nozzles - convergent nozzles	CO-4	Discuss about the Stagnation and critical states	• Lecture • Discussion • Problem solving	

13	Convergent-divergent nozzles – flow through diffusers	CO-4	Discuss about flow through the convergent divergent nozzles	Lecture • Problem solving	
14	Development of a shock wave – rarefaction wave – governing equations, Fanno line, Rayleigh line -Prandtl-Meyer relation – Mach number downstream of the shock wave	CO-4	Explain about the development of a shock wave	• Lecture • Discussion • Problem solving	
15	static pressure ratio across the shock - temperature ratio across the shock – density ratio across the shock - stagnation pressure ratio across the shock	CO-4	Derive the expressions for static pressure ratio and temperature ratio across the shock	• Lecture • Problem solving	**Assignment (Week 15 - 17)**
16	Nature of flow through oblique shock waves – fundamental relations - Prandtl's equation – Rankine-Hugoniot equation.	CO-5	Derive an expression for the Rankine-Hugoniot equation	• Lecture • Problem solving	
17	The Fanno curves – Fanno flow equations – variation of flow parameters.	CO-5	Explain about the Fanno curves	• Lecture • Discussion • Problem solving	**Mid -Test 2 (Week 18)**
18	**Mid Test – 2**				
19/20	**END EXAM**				