MANGALORE UNIVERSITY

DEPARTMENT OF MATHEMATICS

MSC MATHEMATICS

MTS 509	Fluid Mechanics	4 Credits (48 hours)

Prerequisite: Knowledge of syllabus prescribed for the course MTS 456 (Ordinary Differential Equations).

Course Outcome: This course is intended to provide a treatment of topics in fluid mechanics to a standard where the student will be able to apply the techniques used in deriving a range of important results and in research problems. It provides the student with knowledge of the fundamentals of fluid mechanics and an appreciation of their application to real world problems.

Course Specific Outcome:

At the end of the course Students will have the knowledge and skills to understand, explain in depth and apply in various situations the concepts -

- Fundamentals of Fluid Mechanics,
- Develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
- Imbibe basic laws and equations
- fluid flow measurement
- the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.

Unit I - Motion of Inviscid Fluids:

Recapitulation of equation of motion and standard results, Vortex motion-Helmholtz vorticity equation, Permanence of vorticity and circulation, Kelvin's minimum energy theorem - Impulsive motion, Dimensional analysis, Nondimensional numbers.

(8 Hours)

Unit II - Two Dimensional Flows of Inviscid Fluids:

Meaning of two-dimensional flow, Stream function, Complex potential, Line sources and sinks, Line doublets and vortices, Images, Milne-Thomson circle theorem and applications, Blasius theorem and applications.

(10 Hours)

Unit III - Motion of Viscous Fluids:

Stress tensor, Navier-Stokes equation, Energy equation, Simple exact solutions of Navier-Stokes equation: (i) Plane Poiseuille and Hagen- Poiseuille ows (ii) Generalized plane Couette ow (iii) Steady flow between two rotating concentric circular cylinders (iv) Stokes's first and second problems (vi) Slow and steady flow past a rigid sphere and cylinder. Diffusion of vorticity, Energy dissipation due to viscosity. Boundary layer concept, Derivation of Prandtlboundary layer equations, Blasius solution - Karman's integral equation.

(14 Hours)

Unit IV - Gas Dynamics:

Compressible fluid flows, Standard forms of equations of state, Speed of sound in gas, Equations of motion of non-viscous and viscous compressible flows. Subsonic, sonic andsupersonic flows, Isentropic flows, Gas dynamical equations.

(8 Hours)

Unit V - Turbulent Flow:

Introduction, Transition from laminar to turbulent flow, Homogeneous turbulence, Isotropic turbulence, Spatial, time and ensemble averages, Basic properties of averages, Reynolds averaging procedure, Derivation of turbulent equations using Reynolds averaging procedure with gradient-diffusion i.e., K-model for closure.

(8 hours)

References

[1] F. Chorlton, *Text book of Fluid Dynamics*, Van Nostrand, 1967.

[2] L. M. Milne-Thomson, *Theoretical Hydrodynamics*, 4th Ed., Macmillan, 1960.

[3] S. W. Yuan, *Foundations of Fluid Mechanics*, Prentice Hall, 1976.

[4] Z. U. A.Warsi, *Fluid Dynamics*, 2nd Ed., CRC Press, 1999.

[5] B.K. Shivamoggi, *Theoretical Fluid Dynamics*, John Wiley and Sons, 1998.

[6] Stephen B. Pope, *Turbulent Flows*, CambridgeUniversity Press, 2000.

[7] C.S. Yih, *Fluid Mechanics*, McGraw-Hill, 1969.

[8] E.L. Cussier, *Difussion Mass Fluid Systems*, 2nd Ed., Cambridge University Press, 2006.