Course Name: FLUID MECHANICS **Course Code: MAT604**

Credit:04

Course Objective

1. To introduce the learners, the basic properties of fluids, such as viscosity, density, and pressure.
2. To introduce learners the principles of fluid dynamics to analyze the behaviour of fluids in motion, including the effects of turbulence and boundary layers.
3. To introduce learners concepts of mass, momentum and energy conservation to flows.

SYLLABUS

Kinematics of fluids in motion

Basics of fluid: Real fluids and Ideal fluids, Newton's law of viscosity, Newtonian and non-Newtonian fluid, Types of non-Newtonian fluids,hypothesis of continuum,Velocity of a Fluid at a point.

Stream lines, Path lines, steady and Unsteady Flows, Velocity Potential, the Vorticity Vector, Local and Particle Rates of Changes, Equations of Continuity, worked Examples, Acceleration of a fluid, conditions at Rigid Boundary.

Equations of Motion of a Fluid

Pressure at a Point in a fluid at Rest, Pressure at a point in moving Fluid, Conditions at the Boundary of two in-viscous Immiscible Fluids, Euler's Equation of motion, Discussion of the case of steady Motion under Conservative Body Forces.

Two dimensional flow

Meaning of Two Dimensional Flow, Use of Cylindrical Polar Coordinates, The Stream Function, The Complex Potential for two Dimensional,

Irrotational, Incompressible flow, Complex velocity potentials for standard two dimensional flows, some worked Examples, Two-dimensional Image Systems, The Milne Thompson Circle Theorem.

Sources, Sinks and Doublets and Stokes function

Introduction of Sources, Sinks and Doublets, Images in Rigid infinite plane, Axis Symmetric

Flows Stokes Stream Function. Relation between Cartesian Components of Stress Translational Motion of Fluid Elements, The rate of Strain Quadric and principal Stresses, Some further properties of the rate of strain Quadric, stress Analysis in fluid motion, Relation between stress and rate of strain, the coefficient of viscosity and Laminar flow, The Navier-Stokes Equations of Motion of a viscous Fluid. Stokes function, Property of Stokes function, Image of source relative to sphere, Image of doublet relative to sphere.

Course learner outcomes

After completing this course our learners will be able to

1. Recall, comprehend, apply and analyze the various types of Fluids.
2. Recall, understand, and analyze of Fluids in different medium and coordinates system and finding their solutions.
3. Understand, apply and analyze solution of Fluids in different medium through various methods.
4. Remember, comprehend and analyze the Fluids in different medium and their application in real life problems.

UNIT SCHEDULE

BLOCK I: KINEMATICS OF FLUIDS IN MOTION

1. Unit 1: Basics of fluid:

Real fluids and Ideal fluids, Newton's law of viscosity, Newtonian and non-Newtonian fluid, Types of non-Newtonian fluids, hypothesis of continuum,Velocity of a Fluid at a point.

2. Unit 2: Stream lines:

Stream lines, Path lines, steady and Unsteady Flows, Velocity Potential, the Vorticity Vector.

3. Unit 3: Equation of Continuity:

Local and Particle Rates of Changes, Equations of Continuity, worked Examples, Acceleration of a fluid, conditions at Rigid Boundary.

BLOCK II: EQUATIONS OF MOTION OF A FLUID

4. Unit 4: Pressure at a Point in a Fluid at Rest or in a Motion:

Pressure at a Point in a fluid at Rest, Pressure at a point in moving Fluid.

5. Unit 5:Immiscible Fluids

Boundary of two Viscous and in-viscous Immiscible Fluids

6. **Unit 6:Euler‘s Equation of motion**

Euler‘s Equation of Motion under Conservative Body Forces, , Discussion of the case of steady Motion under Conservative Body Forces.

BLOCK III: TWO DIMENSIONAL FLOW

7. **Unit 7:Two dimensional flows**

Meaning of Two Dimensional Flow, Use of Cylindrical Polar Coordinates,

8. **Unit 8:The Stream Function**

The Stream Function, The Complex Potential for two Dimensional,

9. Unit 9: **Standard two Dimensional flows**

Complex Velocity Potentials for Standard two Dimensional flows

10. Unit 10: Two Dimensional Image System

Two-dimensional Image Systems, The Milne Thompson Circle Theorem.

BLOCK IV: SOURCES, SINKS AND DOUBLETS AND STOKES FUNCTION

11. Unit 11: Introduction of Sources

Introduction of Sources, Sinks and Doublets, Sources, Sinks and Doublets. Images in Rigid infinite plane, Axis Symmetric Flows Stokes Stream Function.

12 Unit 12: Relations between Cartesian Components

Relations between Cartesian Components of Stress- Translational Motion of fluid Elements

13 Unit 13:The Rate of strain Quadric and Principal Stresses & its Property

The rate of Strain Quadric and principal Stresses, Some further properties of the rate of strain Quadric, stress Analysis in fluid motion, Relation between stress and rate of strain, the coefficient of viscosity and Laminar flow, The Navier-Stokes Equations of Motion of a viscous Fluid.

14 Unit 14:Stokes function

Stoke's Stream Function Stokes function, Property of Stokes function, Image of source relative to sphere, Image of doublet relative to sphere.

REFERENCES

1. F. Charlatan: *Text Book of Fluid Dynamics*, CBS Publications, Delhi ,1985.
2. R.W. Fox and A.T. McDonald: *Introduction to Fluid Mechanics*, Wiley, 1985.
3. E. Krause: *Fluid Mechanics with Problems and Solutions*, Springer, 2005.
4. B.S. Massey, J.W. Smith and A.J.W. Smith: *Mechanics of Fluids*, Taylor and Francis, New York, 2005.

SUGGESTED READINGS

1. P. Orlandi: *Fluid Flow Phenomena*, Kluwer, New York, 2002.
2. T. Petrila: *Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics*, Springer, Berlin, 2004.