3.6 FLUID MECHANICS

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RATIONALE

Subject of Fluid Mechanics is a basic engineering subject and helps in solving fluid flow problems in the field of Civil Engineering. The subject deals with basic concepts and principles in hydrostatics, hydro kinematics and hydrodynamics and their application in solving fluid - mechanics problems.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Calculate the pressure exerted by fluids on the walls of containers.
CO2: Calculate discharge through pipes, irrigation channels, water supply pipe lines.
CO3: Use different flow measurement devices like Venturimeter, Orificemeter, Notches and Weir.
CO4: Calculate size of the pipe for carrying a particular discharge.
CO5: Differentiate between different types of water pumps used in the field.
CO6: Measure the loss of head in pipes and channels.

DETAILED CONTENTS

UNIT I

1. Properties of Fluids

1.1 Introduction: Fluid Mechanics, Hydrostatics, Hydrodynamics, Hydraulics
1.2 Density or Mass Density, Specific Weight or Weight Density, Specific Volume, Specific Gravity
1.3 Viscosity: Units of viscosity, Kinematic Viscosity, Newton's Law of viscosity, Variation of viscosity with temperature.
1.4 Types of Fluids: Ideal, Real, Newtonian, Non-Newtonian and ideal Plastic fluids.
1.5 Compressibility, Bulk Modulus, Surface Tension, Capillarity, Vapour Pressure and Cavitation

2. Pressure and its Measurement

2.1 Pascal's Law, Fluid pressure at a point and Pressure variation in a fluid at rest.

2.2 Types of Pressure: Absolute Pressure, Gauge Pressure, Vacuum Pressure and Atmospheric Pressure

2.3 Measurement of Pressure: Simple and Differential Manometer (with Numerical Problems)

UNIT II

3. Hydrostatic Force on Surfaces

3.1 Total Pressure and Centre of Pressure

3.2 Vertical, Horizontal Plane surfaces (Rectangular and Trapezoidal) submerged in liquid (No derivation - Simple Numerical Problems)

4. Buoyancy and Floatation

4.1 Buoyancy and Centre of Buoyancy

4.2 Meta-centre and Meta-centric Height

4.3 Analytic Method for Meta-centric Height (Concept only – Simple Numerical Problems)

4.4 Conditions of equilibrium of a floating and sub-merged bodies (Concept only)

UNIT III

5. Flow of Fluids

5.1 Types of Flow: Steady and Unsteady Flow, Uniform and Non-Uniform Flow, Laminar and Turbulent Flow, Compressible and Incompressible Flow

5.2 Discharge and Continuity Equation (No derivation - Simple Numerical Problems)

5.3 Types of hydraulic energy: Potential energy, kinetic energy, pressure energy

5.4 Bernoulli's Theorem: Statement and Description (without Proof of Theorem - Simple Numerical Problems)

6. Flow Measurements

6.1 Venturimeter and Orificemeter (without Proof)

6.2 Pitot-tube and Current meter

6.3 Orifices, Hydraulic Co-Efficient (C_v, C_c and C_d) and their relationship

6.4 Discharge over a Rectangular and Trapezoidal Notch (No Derivation)

6.5 Discharge over a Rectangular and Trapezoidal Weir (No Derivation)

UNIT IV

7. Flow Through Pipes

7.1 Reynold's number, laminar and turbulent flow - explained through Reynold's experiment

7.2 Loss of Energy in Pipes: Major and Minor Energy Losses (No derivation of formula)

7.3 Loss of Energy in Pipes: Simple Numerical Problems

7.4 Hydraulic gradient line and total energy line

7.5 Pipes in series and parallel: Simple Numerical Problems

8. Dimensional Homogeneity

8.1 Secondary and Derived Quantities

8.2 Dimensional Homogeneity

8.3 Dimensional Numbers: Reynold's Number, Froude's Number, Euler's Number, Weber's Number, Mach's Number (Only concept)

UNIT V

9. Flow in Open Channel

9.1 Definition and classification of flow in open channels

9.2 Discharge through open channel by Chezy's formula

9.3 Most economical section of channels (No Derivation - Simple Numerical Problems)

i) Rectangular Channel Section

ii) Trapezoidal Channel Section

10. Hydraulic Pumps

Reciprocating Pump, Centrifugal Pump, Differences between Reciprocating Pump and Centrifugal Pump (No Derivations and Numerical)

PRACTICAL EXERCISES

1. To verify Bernoulli's Theorem
2. To find out Venturimeter Coefficient
3. To determine Coefficient of Velocity (C_v), Coefficient of Discharge (C_d) Coefficient of Contraction (C_c) of an orifice and verify the relation between them
4. To perform Reynold's experiment
5. To verify loss of head in pipe flow due to

a. Sudden enlargement

b. Sudden contraction

c. Sudden bend

6. Demonstration of use of current meter and pitot tube

7. To determine coefficient of discharge of a rectangular notch and triangular notch.

RECOMMENDED BOOKS

1. Jagdish Lal, "Fluid Mechanics and Hyraulics", Delhi Metropolitan Book Co. Pvt Ltd.
2. PN Modi, and SM Seth, "Hydraulics and Fluid Mechanics"; Delhi Standard Publishers Distributors.
3. RS Khurmi, "Hydraulics and Hydraulics Machines", S Chand and Co., Delhi.
4. MP Poonia, and OP Jakhar, "Laboratory Manual for Fluid Mechanics", Standard Publishers Distributors, Delhi.
5. Birinder Singh, "Fluid Mechanics", Kaption Publishing, New Delhi.
6. A.S Sarao, "Fluid Mechanics", Tech. India Publication, New Delhi.
7 e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. http://swayam.gov.in

INSTRUCTIONAL STRATEGY

Fluid Mechanics being a fundamental subject, teachers are expected to lay considerable stress on understanding the basic concepts, principles and their applications. For this purpose, teachers are expected to give simple problems in the class room and provide tutorial exercises so as to develop necessary knowledge for comprehending the basic concepts and principles. As far as possible, the teaching of the subject be supplemented by demonstrations and practical work in the laboratory. Visit to hydraulic research stations must be carried out. This subject contains five units of equal weightage.