The aim to prepare this manual to understand fundamental principles, concepts and significance of various experiments as per existing laboratory experimental practice and evaluation procedure in the subject fluid mechanics and fluid machinery.

The manual explains the procedure for various experiments including principle, apparatus, experimental set up, handling of apparatus, range and accuracy of observations, model calculation, engineering significance, practical applications for each experiment in fluid mechanics and fluid machinery.

This manual also gives comprehensive view about how to perform various experiments, how to presentation of experiment results in the form of laboratory report and how to evaluate performance of a student in the laboratory and how to implement experiment results in field. It also provides to the students the essential information required to understand fundamental concepts, to carry out the experiment and to implement the experiment results in the field. It improves skills in experimentation, presentation and implement of experimental results in the field.

It will help to take accurate observations and analysis of experimental results. Question bank given in separate chapter is useful to students for better understanding concepts and answering viva questions.

This manual also provides necessary valuable information regarding planning and maintenance of Fluid Mechanics and Machinery Laboratory, which helps to the faculty members in setting their own fluid mechanics and machinery laboratory.

This book also contains some other useful information like, SI and conversion table, physical properties units of water, air and common liquids, dimensionless number and various graphs related to viscosity, friction factors and discharge.

Student's performance evaluation procedure has also been discussed in a separate chapter, which is very useful for teachers.

It is hoped that the book will satisfy the needs of the Engineering students preparing for the Degree examinations of almost all the Indian Universities, Diploma examinations conducted by various Boards of Technical Education, Certificate courses as well as for the A.M.I.E., U.P.S.C., G.A.T.E., I.E.S. and other similar competitive and professional Examinations. It should also be of an immense help to the practicing Engineers.
Chapter 1  INTRODUCTION TO FLUID MECHANICS
1-1. Introduction to Fluid Mechanics
1-2. Technological developments in fluid mechanics
1-3. Objectives of Fluid Mechanics and Machinery Laboratory
1-4. Purpose and organization of laboratory manual
1-5. Guidelines for students
1-6. Guidelines for the preparation of laboratory observation book
1-7. Guidelines for the preparation of a laboratory report
Organization and contents
Title or cover page of reports
Contents of Laboratory Reports
(1) Aim
(2) Principle or Concept
(3) Formulae
(4) Apparatus
(5) Experimental setup
(6) Procedure
(7) Observations and Calculations
   (i) Observations
   (ii) Sample Calculations
(8) Graphical presentation of the experimental results
(9) Results and Discussions
(10) Comments
1-8. Evaluation Procedure for students performance in laboratory
1-9. Nomenclature of fluid mechanics and machinery

Chapter 2  PRACTICAL APPLICATION OF FLUID MECHANICS IN VARIOUS FIELDS
2-1. Introduction
2-2. Daily Life
2-3. Applications of Fluid Mechanics in Civil Engineering
2-4. Applications of Fluid Mechanics in Environmental Engineering
2-5. Applications of Fluid Mechanics in Biomedical Engineering
2-6. Applications of Fluid Mechanics in Automobile engineering and Aero-space engineering
University Examination questions

Chapter 3  FUNDAMENTAL CONCEPTS OF FLUID MECHANICS AND THEIR SIGNIFICANCE
3-1. Fluid properties and their significance in Engineering practice
3-1-1. Specific weight and mass density
3-1-2. Specific gravity or Relative density
3-1-3. Viscosity
   (1) Causes of viscosity
   (2) Dynamic viscosity and kinematic viscosity
   (3) Effects of temperature and pressure on viscosity
   (4) Effects of liquid constituents on viscosity
   (5) Newton’s law of viscosity
   (6) Practical application of viscosity
3-1-4. Surface tension
   (1) Effect of temperature
   (2) Practical applications
3-1-5. Capillarity
   Practical examples
3-1-6. Vapour pressure
   (1) Cavitation and its impacts
   (2) Remedial measures for cavitation
3-2. Buoyancy and flotation
3-2-1. Buoyancy and Buoyant force
3-2-2. Archimedes principle (287 B.C. – 212 B.C)
3-2-3. Stability of submerged and floating bodies
   (1) Submerged bodies
   (2) Buoyancy
3-2-4. Stability of floating bodies, metacentre and metacentric height
   Significance of metacentric height
3-2-5. Stability criteria for floating bodies
   (1) Stable equilibrium
   (2) Unstable equilibrium
   (3) Neutral equilibrium
3-3. Different types of fluids
   Classification of fluids
   (1) Viscosity
      (i) Ideal fluids
      (ii) Real fluids (Practical fluids)
   (2) Newton’s law of viscosity
      (i) Newtonian fluids
      (ii) Non-Newtonian fluids
   (3) Angle of contact and forces among molecules
      (i) Wetting fluids
      (ii) Non-wetting fluids
   (4) Compressibility
      (i) Compressible fluids
      (ii) Incompressible fluids
   (5) Various types of non-Newtonian fluids and their properties
3-4. Different types of flow
   (1) Steady and unsteady flow
   (2) Uniform and non-uniform flow
   (3) Laminar flow and turbulent flow
   (4) Compressible flow and incompressible flow
   (5) Ideal fluid flow and real fluid flow
   (6) Rotational flow and Irrotational flow
   (7) Pressure flow and gravity flow
   (8) Free vortex flow and forced vortex flow
3-5. Basic laws of fluid mechanics and their applications
3-5-1. Conservation of mass
3-5-2. Newton’s second law of motion
   Application of Newton’s second law of motion in fluid mechanics
3-5-3. Principle of conservation of angular momentum:
   (law of conservation of moment of momentum)
3-5-4. First law of thermodynamics
   Conservation of energy principle
3-5-5. Second law of thermodynamics
3-5-6. Pascal’s Law for pressure at rest
3-5-7. Pascal’s law of hydrostatic fluid pressure distribution
3-6. Fundamental equations of fluid mechanics
3-6-1. Continuity equation
3-6-2. Energy equation
   (1) Bernoulli’s theorem
   (2) Bernoulli’s equation for real fluid flow
   (3) Bernoulli’s equation for fluid machinery
      (i) Turbines
      (ii) Pumps
      (iii) Pumps and turbine
   (4) Limitations of Bernoulli’s equation
   (5) Application of Bernoulli’s equation
3-6-3. Linear Momentum equation
   (1) Statement
   (2) Application of momentum equation
3-6-4. Angular momentum equation
   Application

Chapter 4  MEASUREMENT OF HYDRAULIC PARAMETERS
4-1. Introduction
4-2. Measurement of fluid properties
4-2-1. Specific gravity and specific weight of a fluid
4-2-2. Capillarity and surface tension
FLUID MECHANICS AND MACHINERY LABORATORY MANUAL
DETAILED CONTENTS

4-2.3. Viscosity
4-3. Measurement of water surface level
4-3.1. Pointer gauge
4-3.2. Float gauge
4-4. Measurement of Pressure, pressure head and pressure gradient
4-4.1. Pressure at a point
(1) Absolute pressure
(2) Gauge pressure
(3) Atmospheric pressure
4-4.2. Pressure head of a fluid
(1) Piezometric head of a fluid
(2) Pressure gradient
4-4.3. Measurement of pressure intensity
4-4.4. Manometer
(1) Manometric liquid
(2) Limitations of manometer
4-4.5. Mechanical Gauges
(1) Bourdon tube pressure gauge
(2) Diaphragm pressure gauge
(3) Dead weight pressure gauge
(4) Pressure transducer
4-4.6. Precautions in pressure measurement
4-5. Velocity measurement
4-5.1. Floats
4-5.2. Pitot Tube
Principle
4-5.3. Pitot static tube
4-5.4. Current meter
4-5.5. Hot-wire anemometer and Hot film anemometer
4-5.6. Laser Doppler Anemometer
4-5.7. The salt velocity method
4-6. Measurement of discharge
4-6.1. Gravity flow
(1) Tanks and reservoirs
(2) Gravimetric method (weight measurement)
(3) Volumetric method
(4) Open channel
4-6.2. Pressure Flow
(1) Bernoulli type devices
4-7. Measurement of head losses
4-7.1. Major energy losses
(1) Darcy-Weisbach equation
(2) Evaluation of friction factor
Moody’s diagram
4-7.2. Minor loss of energy

Chapter 5 PERFORMANCE OF HYDRAULIC MACHINES
5-1. Hydraulic Machines
5-2. Turbines
Classification of turbines
5-2.1. Pelton wheel
Working of Pelton wheel
5-2.2. Francis turbine
Operation of Francis turbine
5-2.3. Kaplan Turbine
Working of Kaplan turbine
5-2.4. Turbines performance and selection
(1) Specific speed
(2) Significance of specific speed
(3) Unit quantities and characteristics curves
(4) Main or constant head or variable speed characteristics curves
(5) Operating or constant speed curves
(6) Constant efficiency curves
5-2.5. Selection of Turbine
5-3. Hydraulic pumps
5-3.1. Reciprocating pump
(1) Working principle of reciprocating pump
(2) Performance of reciprocating pumps
(i) Operating characteristic curves
(ii) Variable speed characteristics curves
5-3.2. Centrifugal pump
(1) Working of a centrifugal pump
(2) Characteristics curves of centrifugal pump
(i) Main characteristics
(ii) Operating speed performance
(iii) Constant efficiency curves
5-3.3. Multi-stage centrifugal pump

Chapter 6 EXPERIMENTS ON FLUID MECHANICS
6-1. Specific weight and specific gravity
6-2. Metacentric height of floating bodies
6-3. Viscosity of liquid
6-4. Verification of bernoulli’s equation
6-5. Coefficients of orifice
6-6. Coefficients of external mouthpiece
6-7. Coefficient of discharge of rectangular notch
6-8. Coefficient of discharge of triangular notch
6-9. Coefficient of discharge of trapezoidal notch
6-10. Coefficient of discharge of cippoletti notch
6-11. Coefficient of discharge of venturimeter
6-12. Coefficient of discharge of orificemeter
6-13. Reynolds number and critical velocity
6-14. Major losses (Friction factor)
6-15. Minor losses – I
6-16. Minor losses – II
6-17. Components of hydraulic jump

Chapter 7 EXPERIMENTS ON FLUID MACHINERY
7-1. Impact of jet on vanes
7-2. Performance studies of pelton wheel
7-3. Performance studies of francis turbine
7-4. Performance studies of kaplan turbine
7-5. Performance studies of centrifugal pump
7-6. Performance studies of reciprocating pump
7-7. Performance of submersible pump test rig
7-8. Performance studies of multistage centrifugal pump

Chapter 8 VIVA QUESTIONS ON FLUID MECHANICS
8-1. Specific Gravity and Specific Weight
8-2. Metacentric height and Buoyancy
8-3. Viscosity
8-4. Pressure measurement
8-5. Bernoulli’s Equation
8-6. Pitot tube
8-7. Mouth piece
8-8. Orifice
8-9. Triangular and Rectangular Notch
8-10. Trapezoidal and Cippoletti notch
8-11. Venturimeter
8-12. Nozzle meter
8-13. Elbow meter
8-14. Rotameter
8-15. Venturi flume and Standing wave flume
8-16. Orifice meter
8-17. Major Losses (Friction Factor)
8-18. Minor losses
8-19. Reynolds number and critical velocity
8-20. Hydraulic jump in rectangular open channel
Chapter 9 VIVA QUESTIONS ON FLUID MACHINERY

9-1. Impact of Jet
9-2. Pelton turbine (impulse turbine)
9-3. Francis turbine
9-4. Kaplan turbine
9-5. Centrifugal pump
9-6. Reciprocating pump
9-7. Jet pump
9-8. Hydraulic ram and hydraulic press

Chapter 10 PLANNING, OPERATION AND MAINTENANCE OF LABORATORY

10-1. Basic Equipment and their specifications for undergraduate courses in Engineering programme
10-2. Grouping of experiments
10-3. Planning aspects of fluid mechanics and machinery laboratory
   (1) Location
   (2) Size
   (3) Spacing between equipment
   (4) Door and window
   (5) Display boards
   (6) Safety measures
10-4. Operation and Maintenance code
10-5. Precautions to be taken in the laboratory
10-6. Relevant IS codes
10-7. Reputed Laboratory Equipment and models suppliers and their details

Appendix A to Appendix I

Appendix A Unit conversion ratios
Appendix B Properties of water at standard atmospheric pressure
Appendix C Physical Properties of Fluids
Appendix D Variation of dynamic viscosity of various fluids with temperature
Appendix E Variation of kinematic viscosity of various fluids with temperature
Appendix F Moody’s diagram for friction factors
Appendix G Determination of pipe diameter for given discharge
Appendix H Dimensionless numbers
Appendix I Properties of some common liquids at 20°C and atmospheric pressure

Index