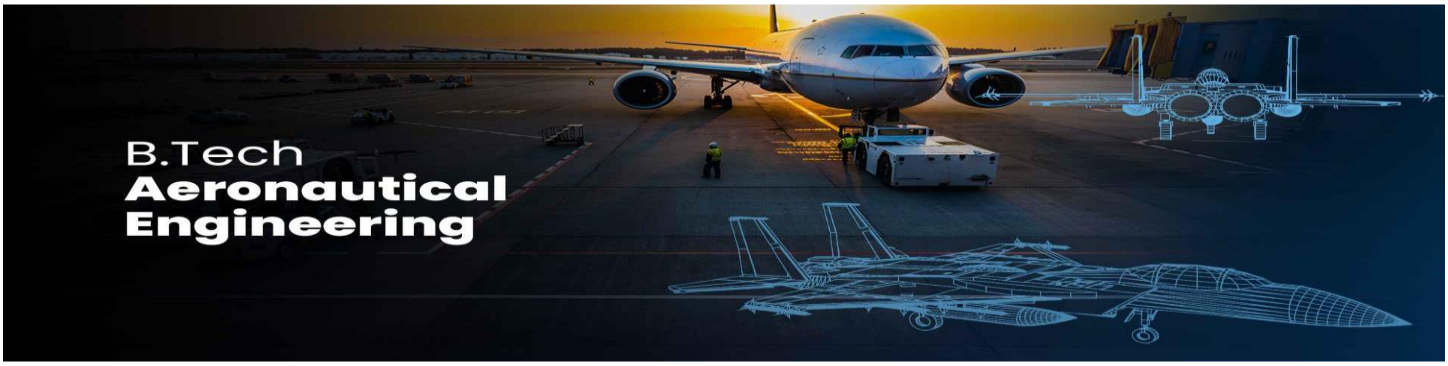
MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS INSTITUTION – UGC, GOVT. OF INDIA)



Department of AERONAUTICAL ENGINEERING

FLUID MECHANICS & SOLID MECHANICS MANUAL

Prepared by:
Mr Shailesh Babu & Mr G Sai Sathyanarayana
Assistant Professor
Department of ANE

FLUID MECHANICS & SOLID MECHANICS MANUAL

B.TECH (R-22 Regulation)
(II YEAR – II SEM)
(2023-24)

DEPARTMENT AERONAUTCAL ENGINEERING

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)
Recognized under 2(f) and 12 (B) of UGC ACT 1956
(Affiliated to JNTUH, Hyderabad, Approved by AICTE - Accredited by NBA & NAAC – 'A' Grade - ISO 9001:2015 Certified)
Maisammaguda, Dhulapally (Post Via. Hakimpet), Secunderabad – 500100, Telangana State, India

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

Affiliated to JNTUHApproved by AICTE, NBA- Tier 1& NAAC – 'A' Grade ISO 9001:2015 Certified)

Maisammaguda, Dhulapally (Post Via. Hakimpet), Secunderabad – 500100, Telangana State, India

SOLID MECHANICS AND FLUID MECHANICS

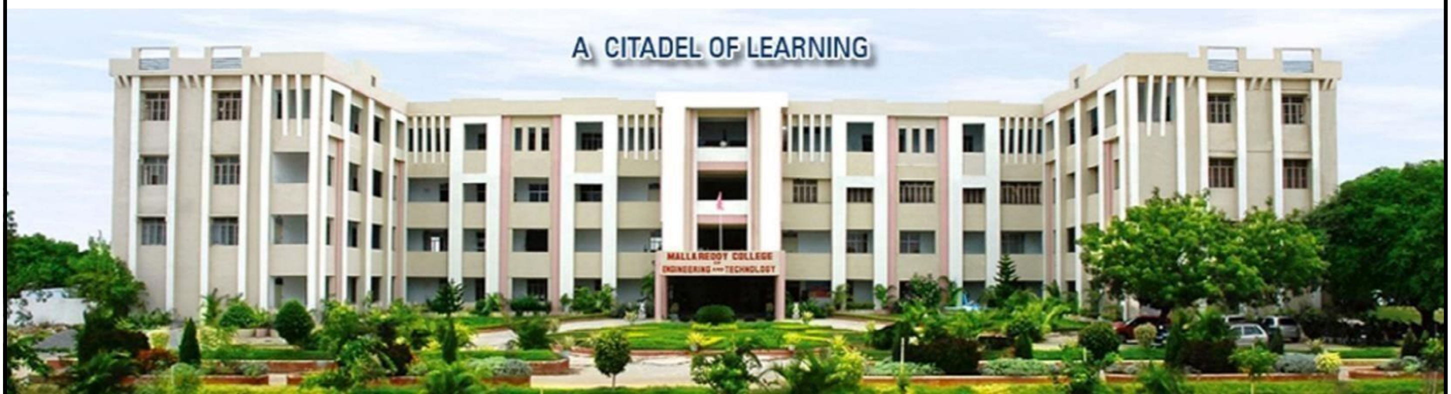
MANUAL

B.TECH II YEAR – II SEM

NAME ____________________

ROLL NO: ____________ BRANCH ____________

YEAR: ____________ SEM: ____________



MRCET CAMPUS

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

Affiliated to JNTUH Approved by AICTE, NBA- Tier 1 & NAAC – 'A' Grade ISO 9001:2015 Certified)

Maisammaguda, Dhulapally (Post Via. Hakimpet), Secunderabad – 500100, Telangana State, India

CERTIFICATE

Certified that this is the Bonafide Record of the work done by Mr. /Ms.___________________ ___________________________bearing Roll No.__________________________ of B.Tech II Year _______________Semester for the Academic year 2023-2024 in__________________________ ________

Date: Faculty In-charge HOD

Internal Examiner External Examiner

INDEX

S.No	Date	Title	Page No	Faculty Sign

INDEX

S.No	Date	Title	Page No	Faculty Sign

Department of AERONAUTICAL ENGIERRING

Vision

- Department of Aeronautical Engineering aims to be indispensable source in Aeronautical Engineering which has a zeal to provide the value driven platform for the students to acquire knowledge and empower themselves to shoulder higher responsibility in building a strong nation..

Mission

- The primary mission of the department is to promote engineering education and research. To strive consistently to provide quality education, keeping in pace with time and technology. Department passions to integrate the intellectual, spiritual, ethical, and social development of the students for shaping them into dynamic engineers.

QUALITY POLICY

- Impart up-to date knowledge to the students in Aeronautical area to make them quality engineers.Make the students experience the applications on quality equipment and tools.Provide systems, resources, and training opportunities to achieve continuous improvement.Maintain global standards in education, training, and services.

PROGRAM OUTCOMES
(PO’s)

Engineering Graduates will be able to:

- Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- Design / development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.
- Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

- Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi disciplinary environments.

- Life- long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM EDUCATIONAL OBJECTIVES – Aeronautical Engineering

- PEO1 (PROFESSIONALISM & CITIZENSHIP): To create and sustain a community of learning in which students acquire knowledge and learn to apply it professionally with due consideration for ethical, ecological and economic issues.
- PEO2 (TECHNICAL ACCOMPLISHMENTS): To provide knowledge based services to satisfy the needs of society and the industry by providing hands on experience in various technologies in core field.
- PEO3 (INVENTION, INNOVATION AND CREATIVITY): To make the students to design, experiment, analyze, and interpret in the core field with the help of other multi disciplinary concepts wherever applicable.
- PEO4 (PROFESSIONAL DEVELOPMENT): To educate the students to disseminate research findings with good soft skills and become a successful entrepreneur.
- PEO5 (HUMAN RESOURCE DEVELOPMENT): To graduate the students in building national capabilities in technology, education and research

PROGRAM SPECIFIC OUTCOMES – Aeronautical Engineering

- To mould students to become a professional with all necessary skills, personality and sound knowledge in basic and advance technological areas.
- To promote understanding of concepts and develop ability in design manufacture and maintenance of aircraft, aerospace vehicles and associated equipment and develop application capability of the concepts sciences to engineering design and processes.
- Understanding the current scenario in the field of aeronautics and acquire ability to apply knowledge of engineering, science and mathematics to design and conduct experiments in the field of Aeronautical Engineering.
- 4. To develop leadership skills in our students necessary to shape the social, intellectual, business and technical worlds.

II Year B.Tech. ANE- II Sem **L/T/P/C**

-/-/3/1.5

(R20A2183) Solid Mechanics and Fluid Mechanics Lab

Objectives:

1. To supplement the theoretical knowledge gained in Mechanics of Solids with practical testing for determining the strength of materials under externally applied loads.
2. To analyze various strength of materials
3. To understand various characterization methods
4. To conduct experiments to verify fundamental principles of fluid mechanics.
5. To calibrate measuring devices and analyze experimental data

(A) SOLID MECHANICS LAB:

1. Direct tension test
2. Torsion test
3. Hardness test
a) Brinells hardness test
b) Rockwell hardness test
4. Test on springs
5. Compression test on cube
6. Impact test
7. Punch shear test

(B) FLUID MECHANICS LAB

8. Calibration of Venturimeter
9. Calibration of orifice meter
10. Verification of Bernoulli's apparatus.
11. Pipe friction.
12. Determination of co-efficient of discharge for external Mouth Piece.

Note: Any 10 experiments can be conducted minimum five from each section.

Equipment

neededSM – lab

1. UTM – 20 / 40 Tons with load Vs Elongation graphical attachment and provision forBending and sheering along with accessories and end grips
2. Deflection test rig (Fabricated hardware + precession dial gauge)
3. Torsion testing Machine
4. Hardness testing Machine (Brinnel and Rockwell)
5. Impact Testing Machine
6. Spring testing Machine.

FM – lab

1. Venturimeter test rig
2. Test rig for Flow over notch
3. Pipe friction apparatus
4. Bernoulli's apparatus
5. test rig for Orifice meter
6. Mouthpiece apparatus.

Outcomes:

1. Prove good understanding of concepts and their applications in the laboratory
2. Analyze various strength of materials through characterization
3. Understand various characterization methods depending on the type of loading.
4. Ability to use equipment for flow measurements.
5. Ability to analyze experimental data and develop empirical equations.

CONTENTS

SOLID MECHANICS LABORATORY

S.No	NAME OF THE EXPERIMENT	PAGE No	EQUIPMENT USED
1	Impact Izod Test	10	Izod impact testing machine
2	Rockwell Hardness Test	13	Rockwell hardness testing machine
3	Brinells Hardness Test	16	Brinell's hardness testing machine
4	Spring Test	19	Spring testing machine
5	Torsion test	22	Torsion testing machine
6	Tensile Test	25	Universal testing machine

FLUID MECHANICS LABORATORY

S.No	NAME OF THEEXPERIMENT	PAGE No	EQUIPMENT USED
1	Calibration of Venturi meter	31	Venturi meter test rig
2	Calibration of Orifice meter	35	Orifice meter test rig
3	Pipe friction factor	40	Pipe friction apparatus
4	Verification of Bernoullis Theorem	45	Bernoullis apparatus
6	Calibration of Coefficient of mouth piece	48	Mouth piece setup

EXPERIMENT -1

IZOD IMPACT TEST

AIM: To perform the izod impact test on materials.

APPARATUS: Izod impact test machine, test specimen, vernier calipers, steel rule.

IMPACT STRENGTH: The resistance of a material to fracture under sudden load application

MATERIALS: Two types of test pieces are used for this test as given.

1) Square cross-section
2) Round cross-section.

THEORY: The type of test specimen used for this test is a Square Cross-section

The specimen may have single, two or three notches. The testing machine should have the following specifications.

The angle between top face of grips and face holding the specimen

vertical=90^0 The angle of tip of hammer =$75^0 \pm 1^0$

The angle between normal to the specimen and underside face of the hammer atstriking

point=$10^0 \pm 1^0$

Speed of hammer at impact=3.99m/sec Striking energy=168N-m or Joules Angle of drop of

pendulum =90^0 Effective weight of pendulum=21.79kg

Minimum value of scale graduation=2 Joules.

Permissible total friction loss of corresponding energy=0.50%

Distance from the axis of rotation of distance between the base of specimen notch and the

point of specimen hit by the hammer=22mm±0.5mm

The longitudinal axes of the test piece shall lie in the plane of swing of the center of gravity of the hammer. The notch shall be positioned so that it is in the plane of the hammer .the notch shall be positioned its plane of symmetry coincides with the top face of the grips .for setting the specimen the notch impact strength I is calculated according to the following relation.

where I= impact strength in joules/m^2

PROCEDURE:

1. For conducting Izod test, a proper striker is to be fitted firmly to the bottom of the hammer with the help of the clamming piece.
2. The latching take for izod test is to be firmly fitted to the bearing housing at the side of the columns.
3. The frictional loss of the machine can be determined by free fall test, raise the hammer by hands and latch in release the hammer by operating lever the pointer will then indicate the energy loss due to friction. From this reading confirm that the friction loss is not exceeding 0.5% of the initial potential energy. Otherwise frictional loss has to be added to the final reading.
4. The specimen for izod test is firmly fitted in the specimen support with the help of clamping screw and élan key. Care should be taken that the notch on the specimen should face to pendulum striker.
5. After ascertaining that there is no person in the range of swinging pendulum, release the pendulum to smash the specimen.
6. Carefully operate the pendulum brake when returning after one swing to stop the oscillations.
7. Read-off position of reading pointer on dial and note indicated value.
8. Remove the broken specimen by loosening the clamping screw.

The notch impact strength depends largely on the shape of the specimen and the notch. The values determined with other specimens therefore may not be compared with each other.

OBSERVATION TABLE:

S .No	A(Area of cross section of specimen)	K Impact energy observed	I Impact Strength

Calculation Part:

RESULT:

EXERCISE PROBLEMS

Perform the same experiment for two different materials i.e., Alluminum and Mild Steel

EXPERIMENT -2

ROCKWELL HARDNESS TEST

AIM: To determine the Rockwell hardness of the given test specimen.

APPARATUS: Rockwell hardness testing machine, test specimen.

THEORY: Hardness-the resistance of a metal to plastic deformation against indentation scratching, abrasion or cutting.

The depth of penetration of the indenter measures the hardness of a material by this Rockwell's hardness test method. The depth of penetration is inversely proportional to the hardness. Both ball or diamond cone types of indenters are used in this test. There are three scales on the machine for taking hardness readings.

Scale „A- with load 60kgf or 588.8N and diamond indenter is used for performing tests on steel and shallow case hardened steel.

Scale „B- with load 100kgf or 980.7 N and 1.588mm dia ball indenter is used for performing tests on soft steel, malleable iron, copper and aluminum alloys.

Scale „C- with load 150kgf or 1471 N and diamond indenter is used for performing tests on steel, hard cost steel, deep case hardened steel , other metals which harder.

First minor load is applied to overcome the film thickness on the metal surface. Minor load also eliminates errors in the depth of measurement due to spring of the machine frame or setting down of the specimen and table attachments.

The Rockwell hardness is derived from the measurement of the depth of the impression. This method of test is suitable for finished or machined parts of simple shapes.

PROCEDURE:

1. Select the load by rotating the nob and fix the suitable indenter.
2. Clean the test piece and place on the special anvil or worktable of the machine.
3. Turn the capstan wheel to evaluate the test specimen into contact with the indenter point.
4. Further turn the wheel for three rotations forcing the test specimen against the indenter. This will ensure the minor load has been applied.
5. As soon as the pointer comes to rest pull the handle in the reverse direction slowly. This releases the major but not the minor load. The pointer will now rotate in the reverse direction.

6. The Rockwell hardness can read off the scale dial, on the appropriate scale, after the pointer comes to rest.

OBSERVATIONS:

Material of the specimen =
Thickness of test specimen =
Hardness scale used =

Test no	Material	Rockwell Scale of weights			Rockwell number			Average Rockwell no.
		Scale	weight	indent	1	2	3	

PRECAUTIONS:

1. For testing cylindrical test specimens use V-type platform.
2. Calibrate the machine occasionally by using standard test blocks.
3. For thin metal prices place another sufficiently thick metal piece between the test specimen and the platform to avoid any damage, which may likely occur to the platform.
4. After applying major load wait for some time to allow the needle to come to rest. The waiting time may vary from 2 to 8 seconds.
5. The surface of the test piece should be smooth and even and free from oxide scale and foreign matter.
6. Test specimen should not be subjected to any heating of cold working.
7. The distance between the centers of two adjacent indentation should be at least 4 times the diameter of the indentation and the distance from the center of any indentation to the edge of the test piece should be at least 2.5 times the diameter of the indentation.

Calculation Part:

RESULT:

EXERCISE PROBLEMS

Perform the same experiment for two different materials i.e., Alluminum and Mild Steel

EXPERIMENT -3

BRINELLS HARDNESS TEST

AIM: To determine the Brinells hardness of the given test specimen.

APPARATUS: Brinells hardness machine, test specimen, Brinells Microscope.

THEORY:

Indentation Hardness-A number related to the area or to the depth of the impression made by an indenter or fixed geometry under a known fixed load.

This method consists of indenting the surface of the metal by a hardened steel ball of specified diameter D mm under a given load F kgf and measuring the average diameter d mm of the impression with the help of Brinell microscope fitted with a scale. The Brinell hardness HB is defined, as the quotient of the applied force F divided by the spherical area of the impression.

HB= Test load in kgf/surface area of indentation

$=2F/ \{\pi D (D- D^2- d^2)\}$ kg/mm^2

Where F = Applied load in kg

D = Diameter of the specified ball in mm

d = Diameter of impression in mm

PROCEDURE:

1. Select the proper size of the ball and load to suit the material under test.
2. Clean the test specimen to be free from any dirt and defects or blemishes.
3. Mount the test piece surface at right angles to the axis of the ball indenter plunger.
4. Turn the platform so that the ball is lifted up.
5. By shifting the lever applies the load and waits for some time.
6. Release the load by shifting the lever.
7. Take out the specimen and measure the diameter of indentation by means of the Brinell microscope.
8. Repeat the experiments at other positions of the test piece.
9. Calculate the value of HB.

OBSERVATIONS:

Test piece material =

Diameter of the ball" D " =

Load section F/D^2 =

Test load =

Load application time =

Least count of Brinell Microscope =

S. No	Diameter Impression			F in kg	D in mm	Average HB Kg/mm^2
	(d_1)	(d_2)	(d_1+d_2)/2			

PRECAUTIONS:

1. The surface of the test piece should be clean
2. The testing machine should be protected throughout the test from shock or vibration.
3. The test should be carried out at room temperature.
4. The distance of the center of indentation from the edge of test piece should be at least 2.5 times the diameter of the indentation and the distance between the center of the two adjacent indentations should be at least 4 times the diameter of the indentation.
5. The diameter of each indentation should be measured in two directions at right angles and the mean value readings used the purpose of determining the hardness number.

Calculation Part:

RESULT:

EXPERIMENT -4

SPRING TEST

AIM: To determine the rigidity modulus of the spring

APPARATUS: Spring testing machine, vernier calipers, spring specimen.

THEORY:

Closed coiled helical springs are the springs in which helix angle is very small or in other words the pitch between two adjacent turns is small, a closed coiled helical spring carrying an axial load.As helix angle in case of close coiled helical springs are small, hence the bending effect on the spring is ignored and we assume that the coils of close coiled helical springs are to stand purely tensional stresses.

Let d=diameter of the spring wire

P= pitch of the helical spring N= number of coils

R= mean radius of the spring coil

W=axial load on spring C=modulus of rigidity

τ=maximum shear stress induced in the wire θ=angle of twist in the spring wire and

x= deflection of spring due to axial load l= length of wire

Net twisting moment on the wire T=WR

But twisting moment is also given by T= $(\pi/16)\ \tau d^3$

From (1) and(2)

above equation which gives the maximum shear stress induced in the wire

(1)

Length of one coil=$2\pi R$

(2)

Total length of the wire=$2\pi Rn$

Strain energy stored by the spring due to torsion

$$U= (\tau /4C)[(\pi/4)d\ 2\pi Rn] \quad (3)$$

Work done on the spring =average load x deflection

$$= (1/2)\ Wx \quad (4)$$

Equating (3) and(4)

$(1/2)\ Wx = (32W^2R^3n)/Cd^4$

$x = 64WR^3n/Cd^4$

Rigidity modulus of the spring $\mathbf{C=64WR^3n/xd^4}$

PROCEDURE:

1) Consider the spring and find out its mean coil radius R with the help of vernier calipers.
2) Find the diameter of the spring and number of turns.
3) Fix the spring between two hooks.
4) Now load is gradually applied.
5) Note the deflection from the deflection scale for different loads applied.
6) Calculate the rigidity modulus using above formula.

PRECAUTIONS:

1) Dimensions should be measure accurately with the help of vernier calipers.
2) Deflection from the scale should be noted carefully and accurately

OBSERVATION TABLE:

S.no	Load applied	deflection	Rigidity modulus C

Average rigidity modulus C =

Calculation Part:

RESULT:

EXPERIMENT -5

TORSION TEST

AIM: To conduct torsion test on mild steel or cast iron specimen to find modulus of rigidity or to find angle of twist of the materials which are subjected to torsion.

APPARATUS:

1. A torsion test machine along with angle of twist measuring attachment.
2. Standard specimen of mild steel or cast iron.
3. Steel rule.
4. Vernnier caliper or a micrometer.

THEORY:

For transmitting power through a rotating shaft it is necessary to apply a turning force. The force is applied tangentially and in the plane of transverse cross section. The torque or twisting moment may be calculated by multiplying two opposite turning moments. It is said to be in pure torsion and it will exhibit the tendency of shearing off at every cross section which is perpendicular to the longitudinal axis.

Torsion equation:

Torsion equation is given by below

$$T / I_P = C\theta/L = \tau/R$$

T= maximum twisting torque (Nmm) I_P = polar moment of inertia (mm^4)

τ =shear stress (N/mm^2)

C=modulus of rigidity ($N/mm^{2)}$

θ=angle of twist in radians

L=length of shaft under torsion (mm)

Assumptions made for getting torsion equation

1. The material of the shaft is uniform throughout.
2. The shaft, circular in section remain circular after loading.

3. Plane sections of shaft normal to its axis before loading remain plane after the torque have been applied.
4. The twist along the length of the shaft is uniform throughout.
5. The distance between any two normal-sections remains the same after the application of torque.
6. Maximum shear stress induced in the shaft due to application of torque does not exceed its elastic limit.

PROCEDURE:

1. Select the suitable grips to suit the size of the specimen and clamp it in the machine by adjusting sliding jaw.
2. Measure the diameter at about the three places and takeaverage value.
3. Choose the appropriate loading range depending upon specimen.
4. Set the maximum load pointer to zero
5. Carry out straining by rotating the hand wheel or by switching on the motor.
6. Load the members in suitable increments, observe and record strain reading.
7. Continue till failure of the specimen.
8. Calculate the modulus of rigidity C by using the torsion equation.
9. Plot the torque –twist graph (T Vs θ)

OBSERVATIONS:

Gauge length **L** =

Polar moment of inertia **IP** =

Modulus of rigidity **$C = TL/I_P\theta$** =

S.No	Twisting Kgf	Moment Nm	Angle of Degrees	Twist Radians	Modulus of rigidity C	Average C N/mm

Calculation Part:

RESULT:

Exercise

Perform the same experiment for two different cross sections on a given specimens For Mild Steel and Alluminum

EXPERIMENT -6

TENSILE TEST

AIM:

To conduct tensile test on a mild steel specimen and determine the following

1. Limit of proportionality
2. Elastic Limit
3. Upper yield point
4. Lower yield point
5. Ultimate strength
6. Fracture strength
7. Young`s Modulus
8. Percentage elongation
9. Percentage reduction in area
10. Ductility
11. Toughness
12. True stress & true strain
13. Malleability

APPARATUS: Universal testing machine, specimen, steel rule, vernier caliper, micrometer

THEORY:

The tensile test is most applied one of all mechanical tests. In this test, a test specimen is fixed into grips connected to a straining device and to a load-measuring device. (One end in stationary grips and the others are in movable grips). If the applied load is small enough, the deformation of any solid body is entirely elastic. An elastically deformed solid will return to its original form as soon as load is removed. However if the load is too large, the material can be deformed permanently. The initial part of the tension curve, which represents the manner in which solid undergoes plastic deformation is termed as plastic. The stress below which the deformation is essentially entirely elastic is known as the elastic limit of the material. In some materials like mild steel a sudden drop in load indicating both an upper and lower yield point denotes the onset of plastic deformation. However some materials do not exhibit a sharp yield point. During plastic deformation at lager extensions, strain hardening cannot compensate for the decrease in section and thus the load passes through a maximum and then begins to decrease. At this stage the ultimate strength, which is defined as the ration of the load on the specimen to the original cross-section area, reaches a maximum value. Until this point the deformation is uniform at all the sections of the specimen. Further loading will eventually cause „neck‟ formation and rupture follows. Usually a tension test is conducted at room temperature; the tensile load is applied slowly. During this test either round or flat specimens may be used. The load on the specimen is applied mechanically or hydraulically depending on the type of testing machine.

1. Nominal/Engg stress and Nominal/Engg strain:

Original C/S area = A_0 (mm^2)

Original gauge length = L_0 (mm)

Increase in gauge length = δL_0

Nominal stress = P/A_0 (N/mm^2)

Nominal strain = $\delta L_0/L_0$

2. Limit of Proportionality:

Stress is proportional to strain up to this point.

Normal Stress = P_A/P_O

Normal Strain = (δL_O) A/L_O

3. Elastic limit:

When the load is removed at "B" , the specimen will go back to original

Dimensions i.e L_O and δ

A_O Nominal stress =

P_B/A_O

Normal Strain = $(\delta L_O)_B/L_O$

If the specimen is loaded beyond elastic limit it will undergo permanent strain ie. Plastic deformation.

4. Upper yield point:

Nominal stress = P_C/A_O

Nominal strain = $(\delta L_O)_D/L_O$

5. Lower yield point:

Nominal stress = P_D/A_O

Nominal strain = $(\delta L_O)_D/L_O$

6. Ultimate load or maximum load point:

Nominal ultimate stress = P_E/A_O

Nominal strain = $(\delta L_O)_E/L_O$

7. Fracture Load point F:

Nominal fracture stress = P_F/A_O

Nominal strain at fracture = $(\delta L_O)_F/L_O$

8. Young`smodulus (E):

Young`s modulus (E) = Stress/Strain

(In elastic region, limit of proportionality=Nominal stress at A/Nominal strain at A

9. Modulus of resilience = (Nominal stress at elastic limit)^2 /2E

Area under Engg. Stress - Strain diagram up to elastic limit

10. Resilience = Modulus of Resilience x Volume of specimen undergoing Tensile stress.

11. Yield point Elongation: Elongation taking place in the specimen from C to D. this is taking place without increase in stress.

12. Modulus of toughness:

Area under engineering stress – strain diagram up to fracture **13. Toughness =** Modulus of toughness x Volume of specimen. This indicates the amount of energy absorbed by the specimen before fracture take place.

14. Ductility= (Final length at fracture – original length 10) x 100

15. Malleability:

It is the ability of the material to undergo plastic deformation prior fracture under compressive loading conditions. In a tensile test it is approximated as percentage reduction in cross sectional area of the specimen. Malleability =

$\{(A_O - A_f)/A_O) \times 100$

True stress – true strain diagram

Engineering stress is calculated based on original cross sectional area (A_O)

But not on the actual cross sectional area at load „P"

True stress = $P/A = P/A_O \times A_O/ A$

Since volume remains constant during plastic deformation we have $A_O L_O = A_L$

True stress = $P/A_O \times L/ L_O$

$= P/A_O \times ((L_O + \delta L_O) /L_O)$

$= P (1+e)$

= Nominal stress (1+ nominal strain)

True strain = Є = 1n (1+e)

These relations are valid up to ultimate load i.e., up to which the strain is uniform all along the gauge length.

1. True Stress at upper yield point = Nominal stress at upper yield point ($1+e_O$) True strain at C = 1n $(1+e_o)$
2. True stress at ultimate load (E_1)= Nominal ultimate stress ($1+e_E$) True strain at ultimate load = 1n $(1+e_E)$
3. True stress at fracture (E_1) = P_f / A_f

   Where A_f is the area of cross section at fracture can be measured. True strain at fracture = 1n(A_o/A_f)

   Area relation is taken instead of lengths because the strains are localized in the region between ultimate load point and fracture point.
4. **Strain Hardening :**

   From lower yield point onwards increase in load is required for increase in strain. Thus the stress required for further deformation is more. This phenomenon is called strain hardening.
5. True – stress – true strain curve in log – log co – ordinates.

   When the true – stress and true – strain are plotted on log – log co – ordinates the curve is a straight line.
6. Ductile and Brittle Materials

   If a material fails without much plastic deformation it can be called brittle.

   If the percentage elongation at fracture is less than 2.5 the material is classified as brittle.

   Usually the metals with F.C.C and CPH structures are highly ductile.

PROCEDURE:

1. Measure the original gauge length and diameter of the specimen.
2. Insert the specimen into grips of the test machine.
3. Begin the load application and record load vs elongation data.
4. Take the readings more frequently as yield point is approached.
5. Measure elongation values.
6. Continue the test till fracture occurs.
7. By joining the two broken halves of the specimen together measure the final length and diameter of specimen at fracture.

RESULTS AND DISCUSSIONS:

1. Plot the Engg. Stress strain curve and determine the following

Limit of proportionality	=	(N/mm^2)
Yield strength	=	(N/mm^2)
Ultimate strength	=	(N/mm^2)
Young`s modulus	=	(N/mm^2)
Percentage elongation	=	%
Percentage reduction in area	=	%
Fracture strength	=	(Nominal /Engg)
Toughness	=	Area under stress – strain curve up to fracture
Malleability		

2. Plot True Stress, True strain curve after calculating true – stress and true strain values at various points.

Estimate

1) Strength coefficient

2) Strain hardening coefficient

3) Determine whether the material is ductile or brittle

4) Comment on the results.

S.No	Load	Deformation	Stress	Strain	E

Calculation part:

Exercise problem

Perform the same experiment on two different materials say Alluminum and Mild Steel and calibrate the stress-strain plots to evaluate the behavior of material under loading.

MECHANICS OF FLUIDS

EXPERIMENT 1

VENTURIMETER TEST RIG

Introduction

A VENTURI METER is a device that is used for measuring the rate of flow of fluid through a pipeline. The basic principle on which a Venturi Meter works is that by reducing the cross - sectional area of the flow passage, a pressure difference is created between the inlet and throat & the measurement of the pressure difference enables the determination of the discharge through the pipe.

A Venturi Meter consists of,

- An inlet section followed by a convergent cone,
- A cylindrical throat,
- A gradually divergent cone.

The inlet section of the Venturi Meter is of the same diameter as that of the pipe, which is followed by a convergent one. The convergent cone is a short pipe, which tapers from the original size of the pipe to that of the throat of the Venturi Meter. The throat of the Venturi Meter is a short parallel side tube having its cross – sectional area smaller than that of the pipe. The divergent cone of the Venturi Meter is a gradually diverging pipe with its cross – sectional area increasing from that of the throat to the original size of the pipe. At the inlet and the throat, of the Venturi Meter, pressure taps are provided through pressure rings.

General Description:

The apparatus consists of (1) Venturimeter (2) Piping system (3) supply pump set (4) Measuring tank (5) Differential manometer (6) Sump

Constructional Specification:

- **Flow Meters:** Consists of Venturimeter of size 25 mm provided for experiments. The meter has the adequate cocks also with them

- **Piping System:** Consists of a set of G.I. piping of size 25 mm with sufficient upstream and down stream lengths provided with separate control valves and mounted on a suitable stand. Separate upstream and down stream pressure feed pipes are provided for the measurement of pressure heads with control valves situated on a common Pipe for easy operation.

- **Supply Pump Set:** Is rigidly fixed on sump. The mono block pump with motor, operating on single phase 220/240 volts 50 Hz AC supply.

- **Measuring Tank:** Measuring tank with gauge glass and scale arrangement for quick and easy measurement.

- **Differential Manometer:** Differential manometer with 1 mm scale graduations to measure the differential head produced by the flow meter.

- **Sump:** Sump to store sufficient water for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

Before commissioning:

- Check whether all the joints are leak proof and water tight.
- Fill the manometer to about half the height with mercury
- Close all the cocks, pressure feed pipes and manometer to prevent damage and over loading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water height and vertically.
- Check proper electrical connections to the switch, which is internally connected to the motor.

Experiments:

- The apparatus is primarily designed for conducting experiments on the coefficient of discharge of flow meters. Each flow meter can be connected to the manometer through the pressure feed opening and the corresponding cocks.

- While taking readings, close all the cocks in the pressure feed pipes except the two (Down-stream and upstream) cocks which directly connect the manometer to the required flow meter, for which the differential head is to be measured. (Make sure while taking reading that the manometer is properly primed. Priming is the operation of filling the manometer upper part and the connecting pipes with water and venting the air fromthe pipes).

- First open the inlet gate valve of the apparatus. Adjust the control valve kept at the exit end of the apparatus to a desired flow rate and maintain the flow steadily.

- The actual discharge is measured with the help of the measuring tank. The differential head produced by the flow meter can be found from the manometer for any flow rate.

CALIBRATION OF VENTURIMETER

Aim: - To calibrate a given venture meter and to study the variation of coefficient of discharge of it with discharge.

Apparatus: - Venturimeter, manometer, stop watch, experimental set-up.

Procedure:-

1. Start the motor keeping the delivery valve close.
2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.
3. By regulating the valve control the flow rate and select the corresponding pressure tapings (i.e. of orifice meter).
4. Make sure while taking readings, that the manometer is properly primed. Priming is the operation of filling the manometer's upper part and the connecting pipes with water by venting the air from the pipes. Note down the difference of head "h" from the manometer scale.
5. Note down the time required for the rise of 10cm (i.e. 0.01m) water in the collecting tank by using stop watch. Calculate actual discharge using below formula.
   Discharge: - The time taken to collect some 'R' cm of water in the collecting tank in m^3/sec.

$$Q_{act} = \frac{AxR}{t}$$

Where: A = area of the collecting tank in m^2 (0.3m X 0.3m)

t = time taken for rise of water level to rise 'R' in't' seconds.

6. Using difference in mercury level "h"calculate the theoretical discharge of venturimeter by using following expression.

$$Q_{th} = \frac{a_1 x a_2 \sqrt{2gH}}{\sqrt{a_1^2 - a_2^2}}$$

Where

H= difference of head in meters = $(h_1 - h_2) \times (\frac{S_m}{S_w} - 1) = (h_1 - h_2) \times 12.6$ m

a_1 = area of venturi at inlet = $\frac{\pi d_1^2}{4}$

a_2 = area of venturi at throat = $\frac{\pi d_2^2}{4}$

g =Acceleration due to gravity
d1 =Inlet diameter in meters.
d2 =Throat diameter in meters.

7. Calculate the coefficient of discharge of orifice meter (Cd):

$$Cd = \frac{Q_{act}}{Q_{theo}}$$

8. Repeat the steps 3 to 7 for different sets of readings by regulating the discharge valve.

S. No.	Venturi inlet diameter d_1	Throat Diameter d_2
1.	25mm	13.5 mm

S. No.	Time for (10 cm) raise of water level in sec.	Actual discharge = Q_a	Differential head in mm of mercury			Theoretical discharge = Q_t	$C_d = Q_q/Q_t$
			h_1	h_2	H		
1							
2							
3							
4							
5							
6					+		
7							
8							
9							
10							

Precautions:

- Do not run the pump dry.
- Clean the tanks regularly, say for every 15days.
- Do not run the equipment if the voltage is below 180V.
- Check all the electrical connections before running.
- Before starting and after finishing the experiment the main Control valve should be in close position.
- Do not attempt to alter the equipment as this may cause Damage to the whole system.

Results and Conclusions:

Exercise

Perform the same experiments for 15 seconds

EXPERIMENT 2

ORIFICE METER TEST RIG

Introduction

An ORIFICE METER is a simple device used for measuring the discharge through pipes. The basic principle on which an Orifice meter works is that by reducing the cross – sectional area of the flow passage, a pressure difference between the two sections before and after Orifice is developed and the measure of the pressure difference enables the determination of the discharge through the pipe. However an Orifice meter is a cheaper arrangement for discharge measurement through pipes and its installation requires a smaller length as compared with Venturi Meter. As such where the space is limited, the Orifice meter may be used for the measurement of discharge through pipes.

General Description

The apparatus consists of (1) Orifice meter (2) Piping system (3) supply pump set (4) Measuring tank (5) Differential manometer (6) Sump

Constructional Specification

- **Flow Meters:** Consists of Orifice meter of size 25 mm provided for experiments. The meter has the adequate cocks also with them.
- **Piping System:** Consists of a set of G.I. piping of size 25 mm with sufficient upstream and downstream lengths provided with separate control valves and mounted on a suitable stand. Separate upstream and downstream pressure feed pipes are provided for the measurement of pressure heads with control valves situated on a common plate for easy operation.
- **Supply Pump Set:** Is rigidly fixed on sump. The mono block pump with motor. Operating on single phase 220/240 volts 50 Hz AC supply.
- **Measuring Tank:** Measuring tank with gauge glass and scale arrangement for quick and easy measurement.
- **Differential Manometer:** Differential manometer with 1 mm scale graduations to measure the differential head produced by the flow meter.
- **Sump:** Sump to store sufficient water for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

Before Commissioning

- Check whether all the joints are leak proof and water tight.
- Fill the manometer to about half the height with mercury
- Close all the cocks, pressure feed pipes and manometer to prevent damage and over loading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertically.
- Check proper electrical connections to the switch, which is internally connected to the motor.

Experiments

- The apparatus is primarily designed for conducting experiments on the coefficient of discharge of flow meters. Each flow meter can be connected to the manometer through the pressure feed opening and the corresponding cocks.

- While taking readings, close all the cocks in the pressure feed pipes except the two (Down-stream and upstream) cocks which directly connect the manometer to the required flow meter, for which the differential head is to be measured. (Make sure while taking reading that the manometer is properly primed. Priming is the operation of filling the manometer upper part and the connecting pipes with water and venting the air from the pipes).

- First open the inlet gate valve of the apparatus. Adjust the control valve kept at the exit end of the apparatus to a desired flow rate and maintain the flow steadily.

- The actual discharge is measured with the help of the measuring tank. The differential head produced by the flow meter can be found from the manometer for any flow rate.

CALIBRATION OF ORIFICE METER

Aim: - To calibrate a given Orifice meter and to study the variation of coefficient of discharge of it with discharge.

Apparatus: -Orifice meter, manometer, stop watch, experimental set-up.

Procedure:-

1. Start the motor keeping the delivery valve close.
2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.
3. By regulating the valve control the flow rate and select the corresponding pressure tapings (i.e. of orifice meter).
4. Make sure while taking readings, that the manometer is properly primed. Priming is the operation of filling the manometer's upper part and the connecting pipes with water by venting the air from the pipes. Note down the difference of head "h" from the manometer scale.
5. Note down the time required for the rise of 10cm (i.e. 0.01m) water in the collecting tank by using stop watch. Calculate actual discharge using below formula.

Discharge: - The time taken to collect some 'R' cm of water in the collecting tank in m^3/sec.

$$Q_{act} = \frac{AxR}{t}$$

Where: A = area of the collecting tank in m^2 (0.3m X 0.3m)
R = rise of water level taken in meters (say 0.1m or 10cm)
t = time taken for rise of water level to rise 'R' in 't' seconds.

6. Using difference in mercury level "h" calculate the theoretical discharge of venturimeter by using following expression.

$$Q_{th} = \frac{a_1 x a_2 \sqrt{2gH}}{\sqrt{a_1^2 - a_2^2}}$$

Where,
H= difference of head in meters = $(h_1 - h_2) \times (\frac{S_m}{S_w} - 1) = (h_1 - h_2) \times 12.6$ m

a_1 = area of orifice at inlet = $\frac{\pi d_1^2}{4}$

a_2 = area of orifice at inlet = $\frac{\pi d_2^2}{4}$

g =Acceleration due to gravity
d1 =Inlet diameter in meters.
d2 =Throat diameter in meters.

7. Calculate the coefficient of discharge of orifice meter (Cd):

$$Cd = \frac{Q_{act}}{Q_{theo}}$$

8. Repeat the steps 3 to 7 for different sets of readings by regulating the discharge valve.

S. No.	Orifice inlet diameter d1	Orifice diameter d2
1.	25mm	13.0

S. No.	Time for (10 cm) raise of water level in sec.	Actual discharge = Q_a	Differential head in mm of mercury			Theoretical discharge = Qt	$C_d = Q_a/Q_t$
			h_1	h_2	H		
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Calculation:-

Precautions:-

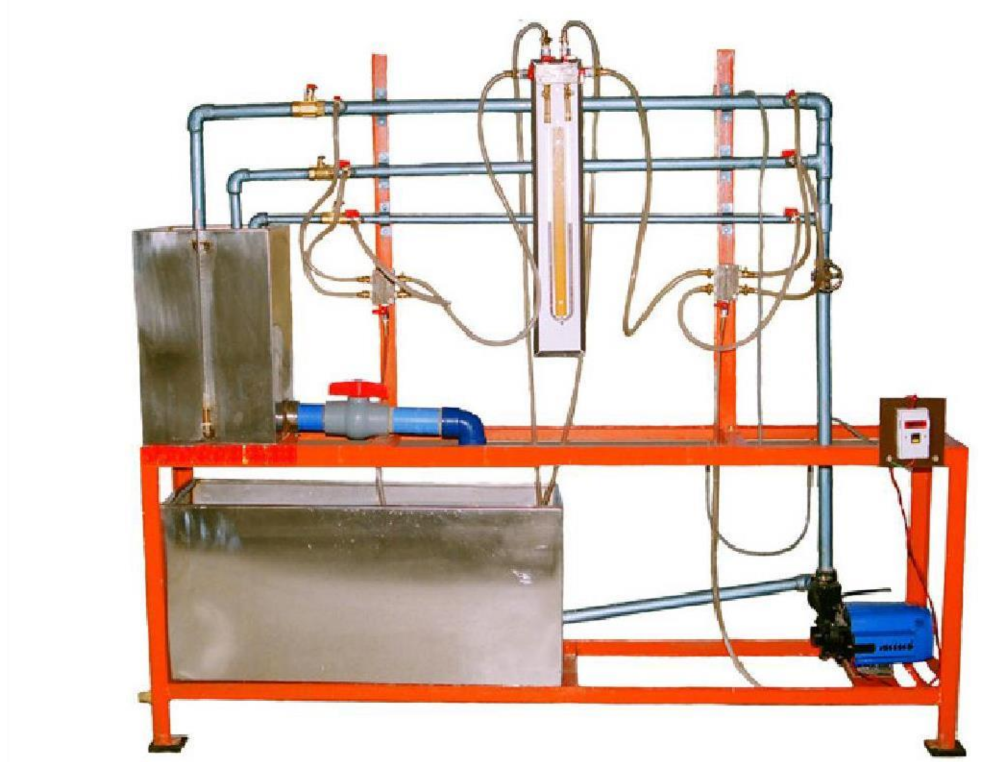
- Do not run the pump dry.
- Clean the tanks regularly, say for every 15days.
- Do not run the equipment if the voltage is below 180V.
- Check all the electrical connections before running.
- Before starting and after finishing the experiment the main
- Control valve should be in close position.
- Do not attempt to alter the equipment as this may cause
- Damage to the whole system.

Results and Conclusions:-

Exercise

Perform the same experiments for 15 seconds

PIPE FRICTION APPARATUS



Introduction

A pipe may be of various diameters and may have bends, valves, etc. When a liquid is flowing through such pipes, the velocity of the liquid layer adjacent to the pipe wall is zero. The velocity of the liquid goes on increasing from the wall and hence shear stresses are produced in the liquid due to viscosity. This viscous action causes loss of energy, which is usually known as Frictional loss.

Here, we are going to consider two important losses that occur during flow,

- **Major Losses.**
- **Minor Losses.**

- **Major losses occur due to friction. This friction may be due to viscosity or roughness in the pipe.**

- **Minor losses can be due to various reasons such as Inlet and Outlet of the pipe, bends, gates, sudden expansions and contractions. The apparatus is designed to study the friction losses that appear in long pipes and the obstructions that are encountered in the way of flow by various types offittings.**

General Description

The unit consists mainly of 1) Piping System 2) Measuring Tank 3) Differential Manometer 4) Supply pump set 5) Sump.

- **Constructional Specification**
- **Piping System:** Piping System of size 12.7 mm, 20 mm and 20 mm (S.S.) dia. With tapings at 1 meter distance and a flow control valve.

- **Measuring Tank:** Measuring tank is provided to measure the discharge of water from the unit.

- **Differential Manometer:** Differential manometer with 1 mm scale graduations to measure the loss of head in the pipe line.

- **Supply Pump Set:** Supply pump set is rigidly fixed on the sump. The pump set is mono block pump with 0.5 HP motor operating on single phase 220 volts 50 Hz AC supply.

- **Sump:** Sump is provided to store sufficient waters for independent circulation through the unit for experimentation and arranged within the floor space of the main unit.

Before Commissioning

- Check whether all the joints are leak proof and watertight.
- Close all the cocks on the pressure feed pipes and Manometer to prevent damage and overloading of the manometer.
- Check the gauge glass and meter scale assembly of the measuring tank and see that it is fixed water tight and vertical.
- Check proper electrical connections to the switch, which is internally connected to the motor.

Experiments

- The apparatus is primarily designed for conducting experiments on the frictional losses in pipes of different sizes. Three different sizes of pipes are provided for wide range of experiments. Each individual pipe can be connected to the Manometer through the pressure feed pipes having individual quick operating cocks.

- While taking reading close all the cocks in the pressure feed pipe except the two (upstream and downstream) cocks, which directly connect the manometer to the required pipe for which the loss in head has to be determined. (Make sure while taking readings, that the manometer is properly primed. Priming is the operating of filling the Manometer upper part and the connecting pipes with water venting the air from the pipes).

- First open the inlet gate valve of the apparatus. Adjust the control valve kept at the exit end of the apparatus to a desired flow rate and maintain the flow steadily.

- The actual discharge is measured with the help of the measuring tank. For each size of the pipe the area of cross section of flow can be calculated from the known diameter of the pipes. From these two valves and the average velocity of stream through the pipe can be calculated.

- The actual loss of head is determined from the Manometer readings. The frictional loss of head in pipes is given by the Darcy's formula.The friction coefficient indicates 'f '.

EXPERIMENT 3

FRICTION FACTOR FOR A GIVEN PIPE LINE

Aim: - To calculate the friction factor for a given pipe line.

Apparatus: - experimental set-up, stop watch.

Procedure:-

1. Start the motor keeping the delivery valve close.
2. The water is allowed to flow through the selected pipe by selecting the appropriate ball valve.
3. By regulating the valve control the flow rate and select the corresponding pressure tapings.
4. Make sure while taking readings, that the manometer is properly primed. Priming is the operating of filling the Manometer upper part and the connecting pipes with water venting the air from the pipes. Note down the loss of head "hf" from the manometer scale.
5. Note down the time required for the rise of 10cm (i.e. 0.1m) water in the collecting tank by using stop watch. Calculate discharge using below formula.

Discharge: - The time taken to collect some 'x' cm of water in the collecting tank in m^3/sec.

$$Q = \frac{A \times R}{t}$$

A = area of the collecting tank in m^2 (0.3m X 0.3m)
R = rise of water level taken in meters (say 0.1m or 10cm)
t = time taken for rise of water level to rise 'r' in 't' seconds.

6. Calculate the velocity of the jet by following formula

$$V = \frac{\text{Discharge}}{\text{Area of the pipe}} = Q/\mathbf{A} \quad \text{m/sec}$$

A = cross sectional area of the pipe= $\Pi d^2/4$
d = pipe diameter

7. Calculate the coefficient of friction for the given pipe by

$$h_f = \frac{4fLv^2}{2gd}$$

.

Where,
h_f - Loss of head of water = $(h_1\text{-}h_2)(S_n/S_o - 1) = (h_1\text{-}h_2)\ 12.6/1000$ m

f - Co-efficient of friction for the pipe
L - Discharge between sections for which loss of head is measured (1 meter)
v - Average velocity of flow in m/sec
g - Acceleration due to gravity 9.81m/sec
d - Pipe diameter in meters

8. Repeat the steps 2 to 7 for different sets of readings by regulating the discharge valve.

Tabular Form:

S. No.	Ø of pipe (mm)	Area (a)	Time for rise of 10 cm water	Discharge	Velocity	Loss of Head h_f	Co-efficient of friction f

Calculation:-

- Total Head, H

$$H = (h_1 + h_2) \times 12.6 \text{ m of water}$$

Where,

12.6 = conversion factor from mercury to water head

- Discharge, Q

$$Q = \frac{A \times R}{t \times 100} \ n^3/s$$

Where,

A = Area of collecting tank = 0.125 m^2.
R = Rise in water level of the collecting tank, cm.
t = time for 'R' cm rise of water, sec
100 = Conversion from cm to m.

- Velocity, V

$$V = \frac{Q}{A^u} \quad \text{m/s}$$

Where, A' = area of the pipe/fitting in use

$$A' = \frac{n \times D^2}{4} \ n^2$$

- Friction Factor,(Major Losses) F:

$$f = \frac{qgH}{LV^2}$$

Where, H = total head, m of water

V = velocity, m

g = acceleration due to gravity, 9.81m/s²

L = Distance b/w tapping = 1.5m

- Head Loss Due To Fittings, (Minor Losses) K:

$$K = \frac{2gK}{V^2}$$

Where, H = total head, m of water

V = velocity, m

g = acceleration due to gravity, 9.81m/s²

Precautions:

1) Do not run the pump dry.
2) Clean the tanks regularly, say for every 15days.
3) Do not run the equipment if the voltage is below 180V.
4) Check all the electrical connections before running.
5) Before starting and after finishing the experiment the main control valve should be in close position.
6) Do not attempt to alter the equipment as this may cause damage to the whole system.

Results and Conclusions:

EXPERIMENT 4

VERIFICATION OF BERNOULLIS THEOREM

Introduction

Bernoulli's Theorem gives the relationship between pressure head, velocity head and the datum. Here the attempt has been made to study the relationship of the above said parameters using venturimeter.

General Description

- The apparatus consists of a specially fabricated clear **ACRYLIC Venturimeter** with necessary tappings connected to a **Multibank Piezometer** also made of clear **ACRYLIC**.
- The apparatus consists of two overhead tanks interconnected with the venturimeter, which is placed in between the tanks.
- The overhead tanks are provided with the Head variation mechanism for conducting the experiments at various heads.
- Water in the sump tank is pumped using a **Monobloc Centrifugal pump** (Kirloskar make) which passes through the control valve to the overhead tank.
- The height of the water in the **collecting tank** is measured using the **acrylic Piezometer** to find the flowrate.
- The whole arrangement is mounted on an **aesthetically** designed **sturdy frame** made of MS tubes and **NOVAPAN Board** with all the provisions for holding the tanks and accessories.

Aim:

- The experiment is conducted to
- Study of Pressure Gradient at different zones.
- Verification of Bernoulli's Equation.
- Comparative analysis under different flow rates

Apparatus:

1) Venturimeter, 2)Piezometer, 3) Overhead Tank, 4)Sump Tank, 5) Centrifugal Pump

Procedure:

1) Fill in the sump tank with clean water.
2) Keep the delivery valve closed.
3) Check and give necessary electrical connections to the system.
4) Switch on the pump & Slowly open the delivery valve.
5) Adjust the flow through the control valve of the pump.
6) Allow the system to attain the steady state. i.e., let the water pass from the second overhead tank to the collecting tank.
7) Note down the Pressure head at different points of the venture meter on the multi-tube piezometer. (Expel if any air is the by inserting the thin pin into the piezometer openings)
8) Close the ball valve of the collecting tank and measure the time for the known rise of water.
9) Change the flow rate and repeat the experiment.

Observation:

Sl. No	Static Head Loss, h										Time for 'R' cm rise in water 'T' sec
	1	2	3	4	5	6	7	8	9	10	
1											
2											
3											
4											
5											

Calculations:

1. Discharge, QA
2.

Where, $$Q = \frac{A \times R}{t \times 100} \; n^3/s$$

A = Area of collecting tank = 0.045 m².
R = Rise in water level of the collecting tank, cm.
t = time for 'R' cm rise of water, sec
100 = Conversion from cm to m.

3. Pressure Head,

Where, $$\text{Pressure Head} = \frac{P}{\rho \times g} = h \quad n \text{ of water}$$

ρ = density of water.
g = gravitational constant
h = head measured, m of water column

3. Velocity Head, $$\text{Velocity Head} = \frac{V^2}{2g} \quad n \text{ of water}$$

Where,
V = **Q / a**, a = Area at the particular section* of the venturimeter m².

4. Verification of BERNOULLI'S EQUATION

Bernoulli's Equation is given as:

After finding, $$\frac{p}{\rho g} + \frac{V}{2g} + z = 0$$

a. Pressure Head, h
b. Velocity head,

at different cross-section of the Venturimeter.

Put the same in the above equation for different points and verify whether all the values obtained are same.

Note: Consider the datum, z to be constant.

Precautions:

- Do not run the pump dry.
- Clean the tanks regularly, say for every 15days.
- Do not run the equipment if the voltage is below 180V.

- Check all the electrical connections before running.
- Before starting and after finishing the experiment the main
- Control valve should be in close position.
- Do not attempt to alter the equipment as this may cause
- Damage to the whole system.

Result and Conclusion

EXPERIMENT 5

Determination of Co-efficient of Discharge for External Mouth Piece

AIM: To observe the variation in the coefficient of discharge of a mouth piece with that inthe head above the mouth piece using a mouth piece apparatus by constant head method.

APPARATUS: 1) Mouth piece apparatus, 2) Stop watch, 3) Scale

DESCRIPTION: The apparatus consists of a mouthpiece fitted to one side of a vertical tank, main water tank and a collecting tank. Water in the main tank can be driven by means of a motor so that it flows in the mouthpiece fitted tank and there by into the collecting tank through the mouth piece. A valve is provided at the site of motor so that flow in the mouth piece fitted tank can be adjusted. The vertical tank is provided with some scale to measure the head of water above the mouth piece. The collecting tank is provided with some scale to read the water level in it and there by volume of water collected can be computed.

THEORY: Mouth piece is a short length pipe which is two or three times its diameter in length, fitted in a tank or vessel containing fluid. It is used to measure the rate of flow offluid.

Mouth piece fitted external to the tank is called external mouthpiece (this is thepresent use with our experiment). The jet of liquid entering the mouth piece constructs toform a vena – contracta. Beyond this section jet again expands and fill the mouth piece completely.

Measurement of coefficient of discharge by Constant head method

Theoretical discharge = $Q_{th} = a\sqrt{2gH}$

Where a – area of mouth piece
H – head of water above the mouth piece

Actual discharge = $Q_{act} = (A \times h) / t$

Where A – area of the collecting tankh –
rise in water level
And t – time for water level to rise by h

Coefficient of discharge is defined as the ratio of actual discharge to theoretical discharge

$$C_d = Q_{act} / Q_{th}$$

PROCEDURE:

1. The main tank is filled with water and the motor is switched on
2. Valve at the motor site is closed to transfer in to the vertical mouth piece fitted tank
3. Time is allowed for the water level to settle at some height above the mouth piece
4. The head of water above the mouthpiece is measured by means of the scale provided at the side of the tank.

5. Time for 5am rise in water level in the collecting tank is noted.
6. The valve at motor site is further closed to achieve another flow rate and the above procedure is adopted.
7. In this manner for 2 more times the similar procedure is repeated and the readings are noted.
8. Readings at 4 different heads are noted in a tabular form..

PRECAUTIONS:

1) Head above the mouth piece should be noted carefully.
2) Time for rise in water level in collecting tank and that for fall in water level in mouth piece fitted tank should be correctly noted.

OBSERVATIONS:

S.No	Time taken for 5 cm rise of water level	Head above mouth piece H cm	Q_{act}	Q_{th}	C_d

MODEL CALCULATIONS:

Theoritical discharge = Q_{th} = a $\sqrt{2gH}$

Where a – area of mouth piece = $\pi d^2/4$
d = dia of mouth piece = 0.01 m
H – head of water above the mouth piece in meters

Actual discharge = Q_{act} = (A X h) / t

Where A – area of the collecting tank = .45x 0.55 = 0.2475 m^2
h – rise in water level (in meters)
t – time for water level to rise by h

$C_d = Q_{act} / Q_{th}$

GRAPHS: 1) Q_{act} Vs H 2) Q_{act} Vs Q_{th} Take Q_{act} on Y-axis

RESULT:

Mean value of Cd of mouth piece = Cd of mouth piece by Graph =