Mission and vision of the Department

Vision of Mechanical Department

To establish the state of the art learning center in Mechanical Engineering which will impart global competence, enterprising skills, professional attitude and human values in the student.

Mission of Mechanical Department

1. To impart quality technical education to the students.
2. To develop comprehensive competence in the students through various modes of learning.
3. To enable students for higher studies and competitive examinations.
4. To facilitate students and industry professionals for continuous improvement and innovation.

Program Educational Objectives:

[1] Use core competence acquired in various areas of Mechanical Engineering to solve techno-managerial issues for creating innovative products that lead to better livelihoods & economy of resources.

[2] To establish themselves as effective collaborators and innovators to address technical, managerial and social challenges.

[3]To equip students for their professional development through lifelong learning and career advancement along with organizational growth.

[4] Serve as a driving force for proactive change in industry, society and nation.

PROGRAM SPECIFIC OUTCOMES

Student should have

1) An ability to work professionally in mechanical systems including design, analysis, production, measurement and quality control.

2) An ability to work on diverse disciplinary tasks including manufacturing, materials, thermal, automobile, robotics, mechatronics, engineering software tools, automation and computational fluid dynamics.

MAHATMA GANDHI MISSION'S

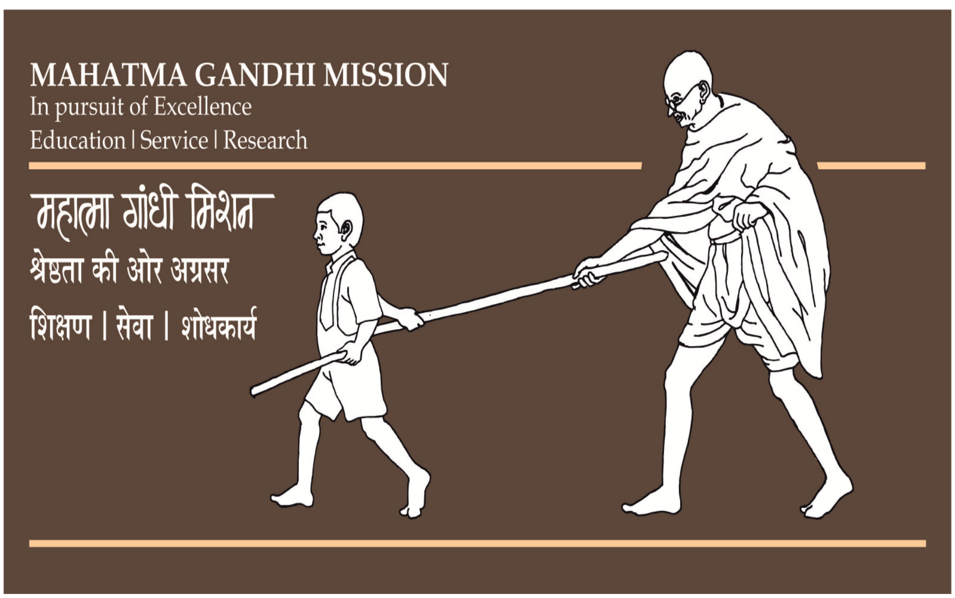
JAWAHARLAL NEHRU ENGINEERING COLLEGE,

AURANGABAD. (M.S.)

DEPARTMENT OF MECHANICAL ENGINEERING

TURBO MACHINES LABORATORY

MANUAL



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MANUAL

Prepared By

Mr. Kirankumar R. Jagtap

Revised & Approved By

Dr.M.S.Kadam
(Head of Department)

’TURBO MACHINES’ EXPERIMENTS

SUBJECTS: - Turbo Machines (B.E.)

LIST OF EXPERIMENTS

Time Allotted for each Practical Session = 02 Hrs.

TR-04.

1)-PUMP With MOTOR.
2)-BASE FRAME.
3)-SUMP TANK.
4)-Measuring Tank.
5)-FUNNEL.
6)-Flow Control Valve.
7)-Pressure Gauge.
8)-Vacuum Gauge.
9)-Control Panel Board.
10)-Dimmer STAT.
11) - Energy Meter.
12) - R.P.M. INDICATOR.

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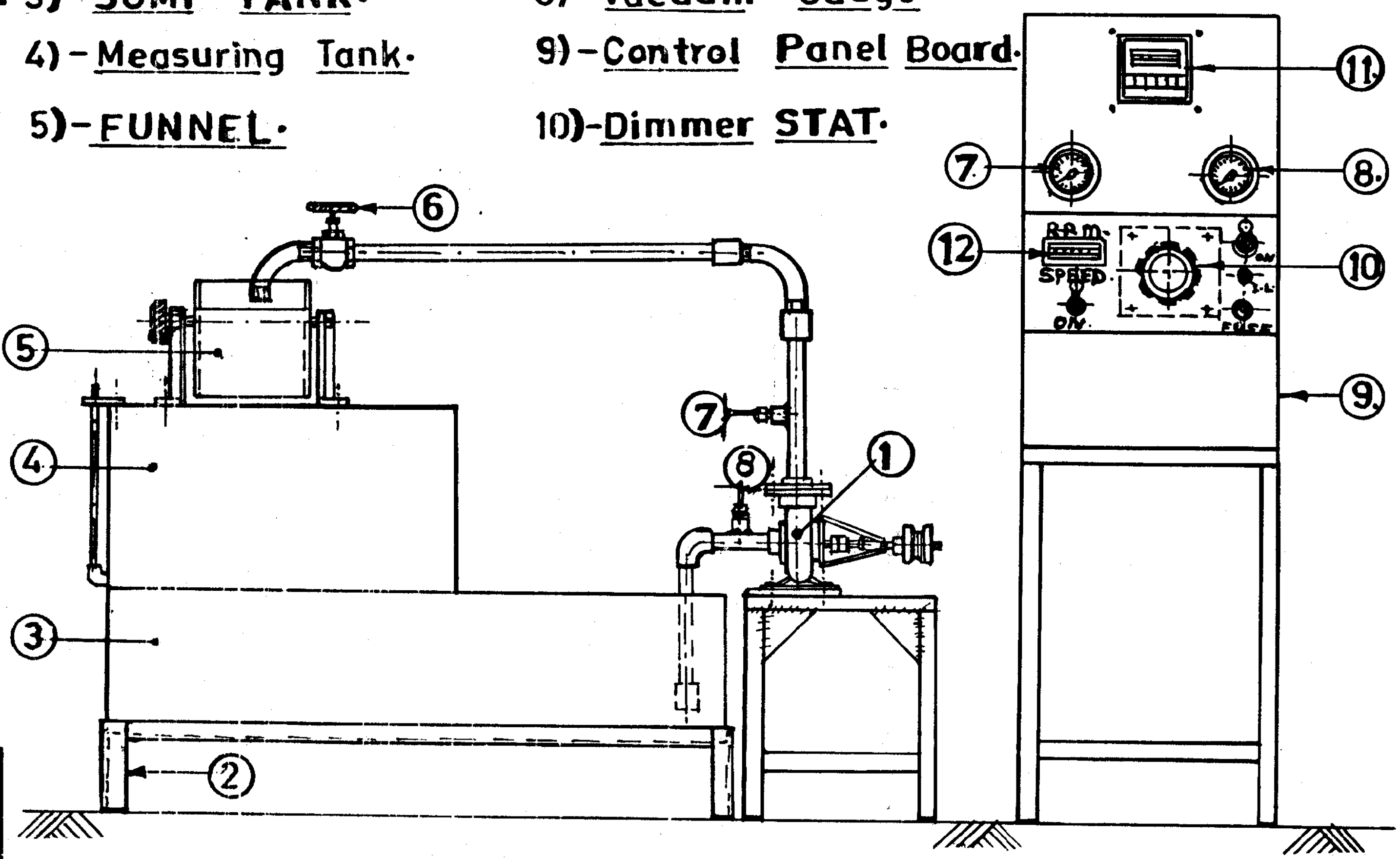


FIG.-2.

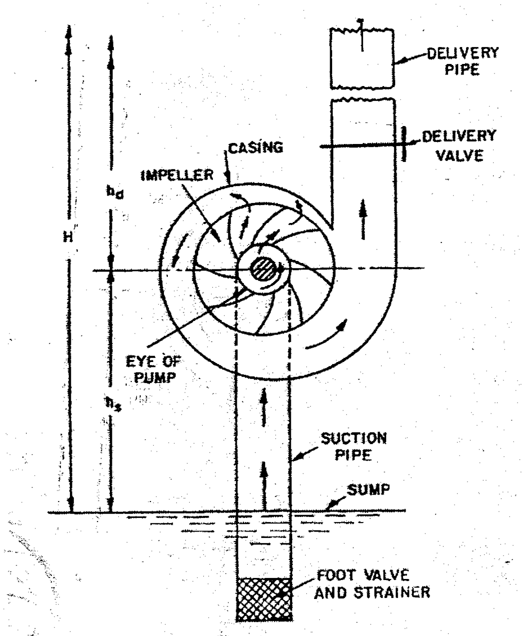
SCHEMATIC LAY-OUT OF:- CENTRIFUGAL PUMP TEST RIG.
(VARIABLE SPEED)

EXPERIMENT NO: I - To Determine the Overall Efficiency of a Centrifugal Pump

AIM-: To determine the overall efficiency of a Centrifugal Pump.

APPARATUS-: Centrifugal Pump Set – Up, Stop Watch, Meter Scale, etc.

THEORY-: The hydraulic machine which converts mechanical energy into hydraulic energy is called as the pump. The hydraulic energy is in the form of Pressure Energy. If Mechanical Energy is converted into Pressure Energy by means of Centrifugal Force which is acting on fluid. This hydraulic machine is called as a Centrifugal Pump. A Centrifugal Pump consists of an impeller which is rotating inside a spiral / volute casing. Liquid is admitted to the impeller in an axial direction through a central opening in it side called the Eye. It then flows radially outward & is discharged around the entire circumference into a casing. As the liquid flows through the rotating impeller, energy is imparted to the fluid, which results in increase in both: the **Pressure Energy,** and the **Kinetic Energy.** The name of pump **Centrifugal** is derived from the fact that, the discharge of liquid from the rotating impeller is due to the centrifugal head created in it when a liquid mass is rotated in a vessel. This results in a pressure rise throughout the mass, the rise at any point being proportional to the square of the Angular Velocity & the distance of the point from the axis of rotation.



Principal parts of a centrifugal pump

DEFINITIONS-:

1) **Static Head-:**

The difference between the liquid level in sump & high level reservoir is called as Static Head / Static Lift, & is represented by "h." It can be divided into two parts –

1) Suction Head ($\mathbf{h_s}$) -: It is the height of liquid level in the sump upto the centre of impeller.
2) Delivery Head ($\mathbf{h_d}$) -: It is the height of liquid level in the high level reservoir measured fro the centre line of the pump.

Thus,

$$\mathbf{H = H_{s} + H_d}$$

2) **TOTAL HEAD-:**

The head which a pump delivers must equal to the static head / lift + all losses in suction pipe, impeller, & delivery pipe. The last term must include the energy losses in strainer valves and bends in the pipe.

Let, h_{fs} & h_{fd} denote the head loss in the suction and delivery pipes respectively. Total head / Total lift is,

$H = h + h_s + h_{fd} + h_{fs}$

Therefore,

$H = h + h_f + Vd^2 / 2g$

Where,

Vd = Velocity in delivery pipe.

h_f = Total head loss in pipe system.

OPERATING CHARACTERISTICS-:

For optimum performance (i.e. operation at maximum efficiency) a centrifugal pump is required to run at its desired speed, which happens to be the speed of driving motor, the head, & discharge from these characteristics. It is possible to a certain whether or not the pump will be able to handle given quantity of liquid against the desired head from **P** vs.**Q** Curve. The size of motor can also be determined by pump through the switch and energy meter. Put on the switch & see that whether the pump rotates in proper direction or not. Put sufficient water in main tank before start to actual practical. Do the priming of the pump if necessary.

PROCEDURE-:

1) Switch on the motor and check the direction of rotation of pump in proper direction.
2) Keep the discharge valve full open and allow the water to fall in main tank.
3) No doubt the speed of the motor is controlled by the hand tachometer.
4) The readings of suction and discharges are noted.
5) Note the power consumed by pump from energy meter.
6) Measure the discharge of the pump in the measuring tank by diverting the flow.
7) Take few readings by varying the discharge.

PRECAUTIONS-:

1) Priming is necessary if pump doesn't give discharge.
2) Leakage should be avoided at joints.
3) Foot valve should be checked periodically.
4) Lubricate the swiveled joints & moving parts periodically.

SPECIFICATIONS-:

Pump type -: Centrifugal Pump Type

Motor Power -: 01 HP

Dimmer Stat -: 04 Amp., Open Type

Energy Meter -: Electrical

Vacuum Gauge -: 0 to 760 mm of **Hg (0 to -30 PSi)**

Pressure Gauge -: 0 to 2.1 kg / cm^2

Observation Table -:

Sr. No.	Pump Speed (N) in rpm	Suction Head 'H_s' (m)	Discharge Head 'H_d' (m)	Discharge 'Q' (lit/sec.)	Time x 10 (sec.)
1					
2					
3					
4					

Calculations -:

Result -: **The overall efficiency of the Centrifugal Pump is ή = ………..%.**

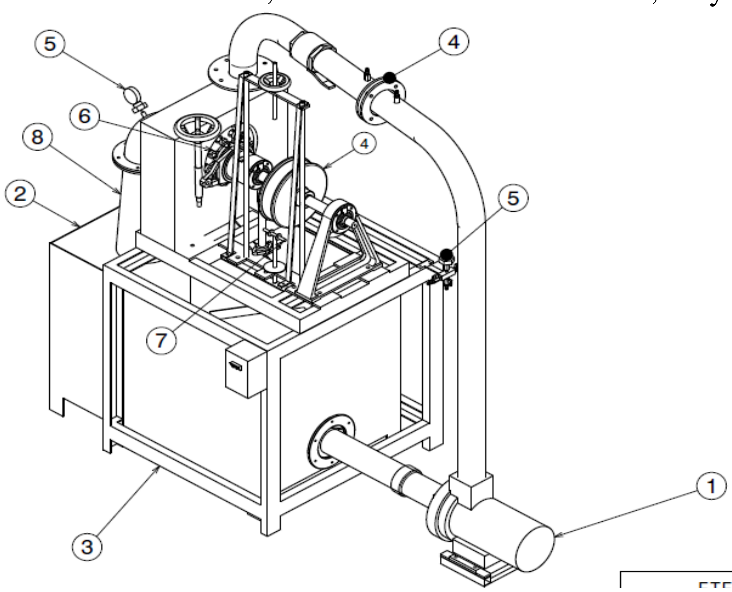
EXPERIMENT NO: II - FRANCIS TURBINE TEST RIG

Objective: - **To determine the efficiency of Francis turbine**

1. INTRODUCTION

The Francis Turbine Test Rig is supplied as a complete set to conduct experiments on model Francis Turbine in Technical Institutions and Engineers Colleges. It has been specially designed to conduct experiments in METRIC UNITS. The test Rig mainly consists of (1) Francis Turbine, (2) A supply pump unit to supply water to the above Francis Turbine, (3) Flow measuring unit consisting of Orificemeter, Pressure Gauge & Piping System, (4) A supply tank made of M.S. with base frame on which entire unit is fixed.

In a reaction turbine, at the entrance to the runner, only a part of the available energy of water is



SR. NO.	ITEM
1	MOTOR
2	TANK
3	STAND
4	PULLEY
5	PRESSURE GUAGE
6	GUIDE VANES
7	WEIGHT HANGER
8	CONE

converted into kinetic energy and a substantial part remains in the form of pressure energy. As water flows through the runner the change from pressure at the inlet to the turbine is much higher than the pressure at the outlet and it varies through out the passage is entirely full of water throughout the passage of water through the turbine.

For this gradual change of pressure to be possible runner in this case must be completely enclosed in an airtight casing and the passage is entirely full of water throughout the operation of the turbine. The difference of pressure between the inlet and the outlet of the runner called reaction pressure, and hence these turbines are known as reaction turbines.

The inward flow reaction turbine having radial discharge at the outlet is known as Francis turbine. In the Francis turbine, the water enters the runner of the turbine in the radial direction at the outlet and leaves in the axial direction at the inlet of the runner.

2. GENERAL DESCRIPTION

The unit essentially consists of a spiral casing, and rotor assembly with runner, shaft and brake drum, all mounted on a suitable study base frame. An elbow fitted draft tube is provided for the purpose of regaining the kinetic energy from the exit water and also facilitating easy accessibility of the turbine due to its location at a higher level than the tail race. A transparent hollow Perspex cylinder is provided in between the draught bend and the Casing for the purpose of observation of flow at exit of runner. A Rope brake arrangement is provided to load the turbine. The output of the turbine can be controlled by adjusting the guide vanes for which a hand wheel and a suitable link mechanism is provided. The Net supply head on the turbine is measured by a pressure and vacuum Gauge. For the measurement of speed, use speed indicator fitted in control panel.

3. CONSTRUCTIONAL SPECIFICATIONS

1.	**Spiral Casing**	is precision moulding out of special Grade Cast Iron for providing smooth surface and better life and less vibration.
2.	**Runner**	is of bronze, designed for efficient operation accurately machined and smoothly finished.
3.	**Guide Vane Mechanism**	Consists of guide vanes made of Gunmetal bushes operated by a hand wheel through a link mechanism. External dummy guide vanes are provided to indicate the position of the actual guide vanes working inside the turbine.
4.	**Shaft**	is a steel accurately machined and provided with a bronze sleeve at the stuffing box.
5.	**Bearing**	One number ball bearing and one number Roller bearing
6.	**Draught Bend**	is provided at the runner with a transparent cylindrical window for observation of flow past the runner. To the bend is connected a draught tube of mild steel fabrication of 500 mm length.
7.	**Brake Arrangement**	Consists of a machined and polished cast Iron brake drum, cooling water pipes, Internal water scoop, discharge pipe, Standard cast iron dead weights, spring Balance, rope brake etc., arranged for Loading the turbine.
8.	**Finish.**	Is of high standard suitably for laboratory Use in Technical Institutions.

4. TECHNICAL SPECIFICATIONS

4-1. Francis Turbine

1. Rated supply head	…	10.0 meters.
2. Discharge	…	1000 lpm.
3. Rated speed	…	800-1000 rpm.
4. Power output	…	1 HP
5. Runner diameter	…	160 mm.
6. No. of guide vanes	…	10 Nos.
7. P.C.D. of guide vanes	…	230 mm.
8. Brake rope diameter	…	13 mm
9. Brake drum diameter	…	214 mm
10. Rope & Hanger Weight	…	0.776 Kg

4.2. Supply Pump set :

1. Rated head	…	6 - 15 meters
2. Discharge	…	30.83 / 17.33 lps
3. Normal speed	…	2880 rpm.
4. Power required	…	5 HP
5. Size of pump	…	100 x 100 mm.
6. Type	…	Centrifugal High speed, Single suction volute.
7. Impeller diameter	…	165 mm.

4.3 Flow Measuring Unit:

Orifice meter material	Aluminum
Orifice Diameter	75 mm
Pressure gauge	0 – 2.1kg / cm^2

4.4 SUMP TANK :

Tank size with fiber lining :		120 x 80 x 80 (cm)
Drain Valve	:	1"

PROCEDURE

STARTING UP

- Make sure before starting that the pipelines are free from foreign matter. Also note whether all the joints are water tight and leak proof.
- Start with closed gate valve.
- The guide vanes in the turbine should also be in the closed position while starting the pump.
- See that all the ball bearings and bush bearings in the unit are properly lubricated.
- Then slowly open the gate valve situated above the turbine and open the cock fitted to the pressure gauge and see that the pump develops the rated head. When the pump develops the required head, slowly open the turbine guide vanes by rotating the hand wheel until the turbine attains the normal rated speed (1000 rpm)
- After that run the turbine at the normal speed for about one hour and carefully note the following

  Operation of the bearing, temperature rise, etc

  Steady constant speed and speed fluctuations if any.
  Vibration of the unit.
- If the operation of the above parts is normal, load the turbine slowly and take readings. To load the turbine standard dead weights are provided with figures stamped on them to indicate their weights
- Do not suddenly load the turbine. Load it gradually and at the same time open the spear to run the turbine at normal speed.

TO SHUT DOWN

- Before switching off the supply pump set, first remove all the dead weights on the hanger.
- Close the cooling inlet water gate valve; slowly close the guide vanes to its fully closed position.
- Then close the gate valve just above turbine. Manometer cocks, Venturimeter cocks should also be closed in order to isolate the manometer.
- Then switch off the supply pump.
- Never switch off the supply pump when the turbine is working under load. If the electric lines trips off when the turbine is working first unload the turbine, close all the valves and cocks.
- Start the electric motor again, when the line gets the power and then operate the turbine by operating the valves in the order said above.

TESTING

Water turbines are tested in the hydraulic laboratory to demonstrate how tests on small water turbine are carried out to, to study their construction, and to give the students the clear knowledge about the different types of turbines and their characteristics. Turbine should be first tested at constant net supply head (at the rated value of 10m) by varying the load, speed and settings. However, the net supply head on the turbine may be reduced and the turbine tested in which case the power developed in the turbine and the best efficiency speed will also be reduced. (Power H1.5 degree Speed H0.5degree)

Though the turbine can be tested at higher net supply heads, the supply pump cannot develop the higher head at the same time maintaining the higher of the flow.

The output power from the turbine is calculated from the readings taken on the brake and the speed of the shaft. The input power supplied to the turbine is calculated from the net supply head on the turbine and the discharge through the turbine. Efficiency of the turbine being the ratio of output and input can be determined from these two readings.

The discharge can be measured by the 75 mm Venturimeter and the manometer fitted with the calibration scale. Supply head is measured with the help of pressure gauge.(any calibration , error of the gauge, the difference in the level of the pressure gauge, and the jet center line should also be taken into account.) the speed of the turbine can be measured with the Speed Indicator fitted in control panel.

It is suggested that the turbine should be tested at normal speed, three speeds below the normal speed, and three speeds above the normal speed covering the range of ±50% of the normal speed for each setting of the guide vanes. The run away speed (the speed of the turbine at no load and rated condition of the supply head) and pull out torque (the maximum torque at stalled speed) may also be observed.

After starting and running the turbine at normal speed for some time, load the turbine and take readings for following

- Net supply head (pressure gauge readings plus the height of the gauge center above the center line of the jet.)
- Turbine shaft speed.
- Brake weight
- Spring balance reading

OBSERVATION

Runner outside diameter	=	150mm
Hub diameter	=	78mm
No. Of runner blades	=	4
No. Of guide vanes	=	10
P.C.D.guide vanes	=	230mm
Brake drum diameter	=	214mm
Rope diameter	=	13mm
Size of orifice meter	=	100mm
Area ratio	=	0.56
Orifice diameter	=	75mm
Discharge Q	=	$k \sqrt{p_1 - p_2}$

OBSERVATION TABLE

Sr. no	P = Inlet Pr. Gauge Reading (Bar)	Orifice meter Pressure (Bar)			Discharge (m^3/sec)	Load on turbine (Kg)		Net Wt (Kg)	Speed (RPM)	Power (KW)		η
		p_1	p_2	H= (p1-p2)	Q	W_1	W_2	W	N	O/P	I/P	
1												
2												
3												

CALCULATION

I/P = Input power in KW

I/P = γ QH

Where,

γ = Specific weight of water = 9.81 KN/ m^3

Q = Discharge in m^3/sec = $k \sqrt{p_1 - p_2}$

$K = C_d \times (\pi / 4) \times d_O^2 \times \sqrt{2 \times g}$

$K = 0.68 \times (\pi / 4) \times (0.075)^2 \times \sqrt{2 \times 9.81}$

K = 0.01329

h = Pressure gauge difference for orifice meter

= $(p_1 - p_2) \times 10$ meter

H = Inlet pressure head reading in meter

= (Pressure gauge reading) x 10 meter

O/P = Output Power in KW

$$\text{O/P power} = \frac{2\pi NT \times 9.81}{60000}$$

Where,

N = Turbine speed in RPM

T = Torque = net load x effective radius in Kg mt

R = effective radius of the brake drum = 0.1065

mtr n = net loading in Kg

= (Dead wt. + Wt. of rope and wt hanger) – Spring Balance

η = Efficiency of turbine in %

$$\eta = \frac{\text{Output}}{\text{Input}} \times 100$$

RESULT SHEET

OBSERVATION

Runner outside diameter	=	150mm	=	0.150 m
Hub diameter	=	78mm	=	0.078 m
No. Of runner blades			=	4
No. Of guide vanes			=	10
P.C.D.guide vanes	=	230mm	=	0.230 m
Brake drum diameter	=	200mm	=	0.200 m
Rope diameter	=	13mm	=	0.013 m
Size of orifice meter	=	100mm	=	0.100 m
Area ratio			=	0.56
Orifice diameter	=	75mm	=	0.075 m

Discharge Q = $k\sqrt{h_1 - h_2}$

OBSERVATION TABLE - I

FOR CONSTANT SPEED BY VARYING GUIDE VANES OPENINGS

Sr no	P = Pr. Head (Bar)	Orifice meter Pressure (Bar)		Discharge (m^3/sec)	Load on turbine (Kg)		Speed (RPM)	Power (KW)		η %
	H	p_1	p_2	Q	W_1	W_2	N	I/P	O/P	
1	1.4	1.95	1.9	8.04×10^{-3}	0	0	1130	1.10	0	0
2	1.4	1.9	1.85	8.04×10^{-3}	1	0.2	1130	1.10	0.32	29
3	1.3	1.85	1.8	8.04×10^{-3}	2	0.4	1130	1.02	0.47	46
4	1.25	1.8	1.75	8.04×10^{-3}	3	0.5	1130	0.98	0.65	66
5	1.17	1.7	1.65	8.04×10^{-3}	4	0.5	1130	0.92	0.84	91
6	1.1	1.625	1.55	9.85×10^{-3}	5	0.7	1130	1.06	0.99	93
7	0.85	1.375	1.25	0.0127	6	0.8	1130	1.05	1.16	110

CALCULATION

Q = Discharge in m^3/sec

$$Q = K\sqrt{p_1 - p_2}$$

Where,

$$K = C_d \times (\pi / 4) \times d_O^2 \times \sqrt{2 \times g \times 10}$$

$$= 0.68 \times (\pi / 4) \times 0.075^2 \sqrt{2 \times 9.81 \times 10}$$

K = 0.01329

$$Q = 0.0396\sqrt{1.8 - 1.75}$$

$Q = 8.04 \times 10^{-3}\ m^3/ sec$

I/P = Input power in KW

$$I/P = \gamma QH$$

Where,

γ = Specific weight of water = 9.81 KN/ m^3

H = Inlet pressure head reading in meter

= (Pressure gauge reading) x 10 meter

= (1.25) x 10 meter

H = 12.5 meter

$$I/P = 9.81 \times 8.04 \times 10^{-3} \times 13.5$$

Input Power = 0.98 KW

O/P = Output Power in KW

$$\text{O/P power} = \frac{2\pi NT \times 9.81}{60000}$$

Where,

T = Torque in N – m

T = Net load x effective brake drum radius

Where,

n = net loading in Kg

= (Dead wt. + Wt. of rope and wt hanger) – Spring Balance reading

= (3 + 0.5 + 0.4) – 0.5

n = 3.4 Kg

r = Effective brake drum radius = 0.165 meter

T = 3.4 x 0.165 = 0.561 Kg - m

N = Turbine speed = 1130 RPM

$$\text{O/P power} = \frac{2\pi \times 1130 \times 0.561 \times 9.81}{60000}$$

Out put Power = 0.65 KW

η = Efficiency of turbine in %

$$\eta = \frac{\text{Output}}{\text{Input}} \times 100$$

$$\eta = \frac{0.59}{0.98} \times 100$$

Efficiency (η) = 0.66 or 66 %

OBSERVATION TABLE - II

FOR FULL OPENINGS

Sr no	P = Pr. Head (Bar)	Orifice meter Pressure (Bar)		Discharge (m^3/sec)	Load on turbine (Kg)		Speed (RPM)	Power (KW)		η
	H	p_1	p_2	Q	W_1	W_2	N	I/P	O/P	
1	0.98	1.45	1.35	0.0113	0	0	1816	1.08	0	0
2	0.98	1.45	1.3	0.0139	1	0.2	1680	1.33	0.48	0.36
3	0.85	1.4	1.25	0.0139	2	0.3	1580	1.15	0.69	0.60
4	0.85	1.4	1.25	0.0139	3	0.5	1460	1.15	0.84	0.73
5	0.85	1.35	1.25	0.0113	4	0.6	1350	0.94	0.98	1.04
6	0.85	1.4	1.25	0.0139	5	0.7	1210	1.15	1.16	1.00
7	0.8	1.35	1.2	0.0139	6	0.85	1126	1.09	1.15	1.05
8	0.8	1.35	1.2	0.0139	7	1	1012	1.09	1.18	1.08

CALCULATION

Q = Discharge in m³/sec

$$Q = K\sqrt{p_1 - p_2}$$

Where,

$$K = C_d \times (\pi / 4) \times d_O^2 \times \sqrt{2 \times g \times 10}$$

$$= 0.64 \times (\pi / 4) \times 0.075^2 \sqrt{2 \times 9.81 \times 10}$$

K = 0.0396

$$Q = 0.0396\sqrt{1.4 - 1.25}$$

$Q = 0.0139\ m^3/\ sec$

I/P = Input power in KW

I/P = γ QH

Where,

γ = Specific weight of water = 9.81 KN/ m^3

H = Inlet pressure head reading in meter

= (Pressure gauge reading) x 10 meter

= (0.85) x 10 meter

H = 8.5 meter

I/P = 9.81 x 0.0139 x 8.5

Input Power = 1.15 KW

O/P = Output Power in KW

$$\text{O /P power} = \frac{2\pi NT \times 9.81}{60000}$$

Where,

T = Torque in N – m

T = Net load x effective brake drum radius

Where,

n = net loading in Kg

= (Dead wt. + Wt. of rope and wt hanger) – Spring Balance reading

= (3 + 0.5 + 0.4) – 0.5

n = 3.4 Kg

r = Effective brake drum radius = 0.165 meter T = 3.4 x 0.165 = 0.561 Kg - m

N = Turbine speed = 1460 RPM

$$= \frac{2\pi \times 1460 \times 0.561 \times 9.81}{60000} \text{ O/P power}$$

Out put Power = 0.84 KW

η = Efficiency of turbine in %

$$\eta = \frac{\text{Output}}{\text{Input}} \times 100$$

$$\eta = \frac{1.15}{0.84} \times 100$$

Efficiency (η) = 0.73 or 73 %

EXPERIMENT NO: III –

TO CONDUCT A TEST ON PELTON WHEEL TURBINE AT A CONSTANT HEAD

AIM: **To conduct a test on Pelton Wheel Turbine at a Constant Head**

APPARATUS:

1. Pelton Wheel Turbine
2. Nozzle & Spear Arrangement
3. Pressure Gauges (03 Nos. – Range = 00 – 07 kg/cm^2)

THEORY:

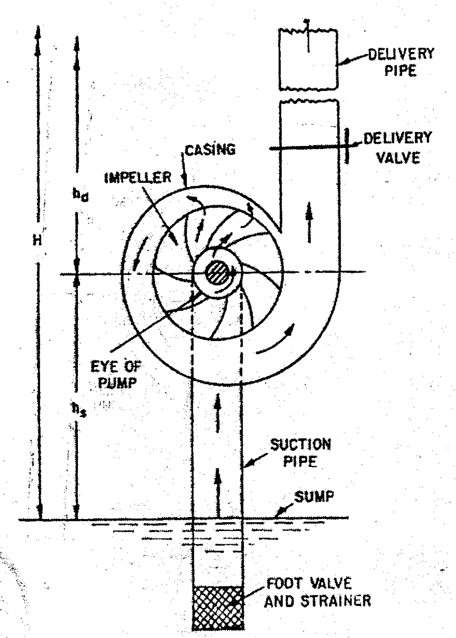
Pelton Wheel Turbine is an IMPULSE type of turbine which is used to utilize high head for generation of electricity. All the energy is transferred by means of Nozzle & Spear arrangement. The water leaves the nozzle in a jet formation. The jet of water then strikes on the buckets of Pelton Wheel Runner. The buckets are in the shape of double cups joined together at the middle portion. The jet strikes the knife edge of the bucket with least resistance and shock. Then the jet glides along the path of the cup & jet is deflected through more than 160 – 170 degrees. While passing through along the buckets, the velocity of water is reduced & hence impulse force is applied to the cups which are moved & hence shaft is rotated.

The Specific Speed of Pelton wheel varies at constant head.

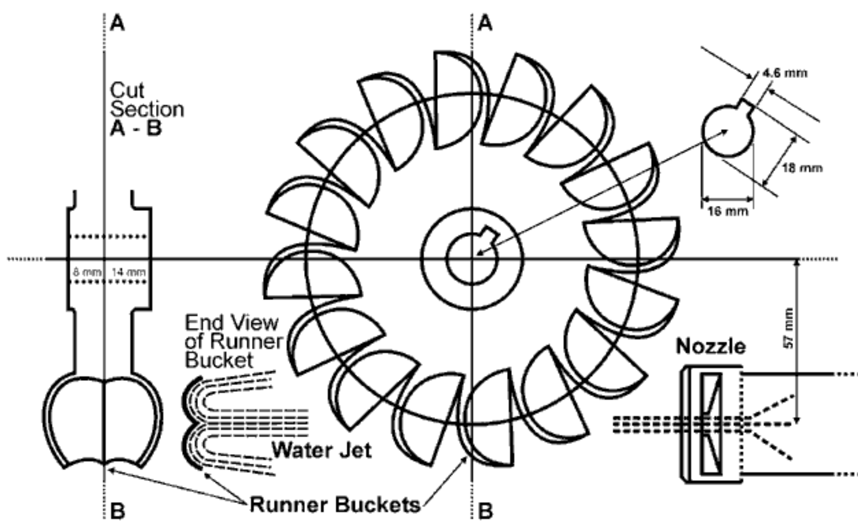
TEST REQUIREMENTS:

The Pelton Wheel is supplied with water at high pressure by Centrifugal Pump. The water is converged through Venturimeter to the Pelton Wheel. The Venturimeter with manometer connection is to be determined. The nozzle opening can be positioned and decreased by operating Spear wheel at the entrance side of turbine. The Spear wheel can be positioned in 8 places, i.e. 1/8,2/8,3/8,4/8,5/8,6/8,7/8,8/8 of nozzle opening. The turbine can be loaded by applying loads on brake drums by means of placing the given loads on the loading arm also placing the given loads on the loaded turbine.

The speeds (r.p.m.) at the entrance can be measured with the help of Tachometer.



Principal parts of a centrifugal pump



PROCEDURE:

1. Keep the nozzle opening at the required position.
2. Do the priming & start the pump.
3. Allow the water in the turbine to rotate it.
4. Note down the speed of the turbine.
5. Take the respective readings in the respective pressure gauges.
6. Load the turbine by putting the weights.
7. Note down the dead weights.
8. Also note down the Head level.
9. Repeat the same procedure for different loading conditions.

SPECIFICATIONS:

1. Diameter of Drum		=	40 cms	=	0.4 m
2. Diameter of Rope		=	15 mm	=	0.015 m
3. Total diameter	(D)	=	415 mm	=	0.415 m

OBSERVATION TABLE:

Sr. No.	Pressure Gauge Readings in Kg/cm^2			Head (H)=P/W Meters	Q_{act}= 0.0055 x $(H)^{1/2}$	Speed (N) in rpm	H at inlet of turbine		Dead Weight T_1 in Kg	Spring Weight T_2 in Kg	Weight of Hanger T_0 in Kg	Resultant Load (T)= $T_1 + T_0 - T_2$ in Kg	B.H.P. = πDNT/ 60x75	I.H.P.= WQH/ 75	% Efficiency = BHP/IHP X 100
	P_1	P_2	P_3				P Kg/cm^2	H In m							
01															
02															
03															
04															
05															

RESULT: **Avg. Efficiency of the Pelton Wheel Turbine = ……………………..%**

EXPERIMENT NO: IV –

PERFORMANCE TEST ON GEAR (OIL) PUMP

AIM: To conduct the performance test on the given oil gear pump and to draw the characteristic curves.

DESCRIPTION: Gear pump Test Rig consists of a Gear Pump, connected to a motor, mounted on a reservoir tank. A collecting tank is also mounted adjacent to the pump so that the oil is pumped from reservoir to the collecting tank through suction and delivery pipe. A delivery valve controls the output pressure. The oil from the collecting tank is discharged into the reservoir by opening the gate valve of the upper tank. The power required by the pump is obtained by rotation of the disc in the Energy meter.

EXPERIMENTAL PROCEDURE:

- Close the delivery gate valve completely.
- Start the motor and adjust the gate vale to the required pressure and delivery.

Note the following readings

- ✓ The pressure and vacuum gauge readings
- ✓ The time 'te' for 'N' revolutions of energy meter disc
- ✓ The time 'te' for 'h' cm rise of water collecting tank.
- ✓ The above steps are repeated for different values of discharge.

- Switch off the monitor.
- Calculate the input, output and efficiency.

CALCULATIONS:

1. **Discharge** = Ah/tc
2. **Head : [H]** = $h_d + h_s + h_g$
3. **Output of the pump :** = γQH W
4. **Input of the pump:** = $(3600 \times 1000 \times N_2 x\ \eta 1 \times \eta 2)/Nt_e$ Watts.
5. **Efficiency :** = $\frac{Output}{Input} \times 100$

A = Area of collecting tank [l x b]

γ = Specific weight of oil (N/m^3)

Q = Discharge (m^3/sec)

H = Total head (m of water)

N = Number of revolutions from the energy meter disc

$\eta 1$ = Efficiency of pump

$\eta 2$ = Efficiency of energy meter disc

OBSERVATIONS:

Energy Meter Constant (N) = ……………

Efficiency of Motor (η_1) = ……………

Efficiency of Energy Meter (η_2) = ……………

Breadth of Collecting Tank (b) = ……………

Length of Collecting Tank (l) = ……………

DATASHEET:

Sr No.	Pressure Gauge Readings (H_d)		Total Head [H] m	Time for N_2 rev. in Sec. (t_e)	Discharge (Q)=Ah/t_c in m^3/sec.	Input (W_1)	Output (W_2)	Efficiency (%η)
	Kg/cm^2	'm' of Water						

GRAPHS:

Discharge vs. Head

Discharge vs. Efficiency

Discharge vs. Output

RESULT:

The performance of submersible pump is conducted and characteristic curves are drawn.

Efficiency = ………….. %

Discharge = …………..m^3/sec.

EXPERIMENT NO: V -

CAVITATION TEST RIG APPARATUS

Introduction:

Cavitation is most unpleasant hydrodynamic phenomenon, whose harmful effects are both widespread and obvious and seriously handicap many phase of science and engineering. Conversely its basic nature has long been veiled in mystery and only recently it is beginning to understood. Cavitation is a liquid phenomenon and does not occur under any normal circumstances either in solids or gases. It is seldom observed in concerned field because it normally occurs within closed opaque conduits. But now with the help of this set up demonstration of its direct appearance and measurement of conditions is possible. Thus it is very helpful for better understanding of cavitation supports the theoretical statements boosts the further study in this regard. Here with this setup controlled cavitation could be produced, defected & located.

CAVITATION:

The Phenomenon of cavitation was first observed in 1885 during the testing of marine propellers and subsequently on the blades of water turbines working under high heads. In spite of various investigations the cause of destruction in completely convincing manner.

The phenomenon of cavitation could be described as follows: **"When a body of liquid is heated under constant pressure on when its pressure is reduced at constant temperature by static or dynamic means, a state is reached ultimately at which vapor gas and vapor filled bubbles or cavities become visible & grow. The pressure is called as vapor pressure zone they collapse and the liquid around it rushes to the centre of the cavity and a shock wave of sound is produced which leads to vibration."**

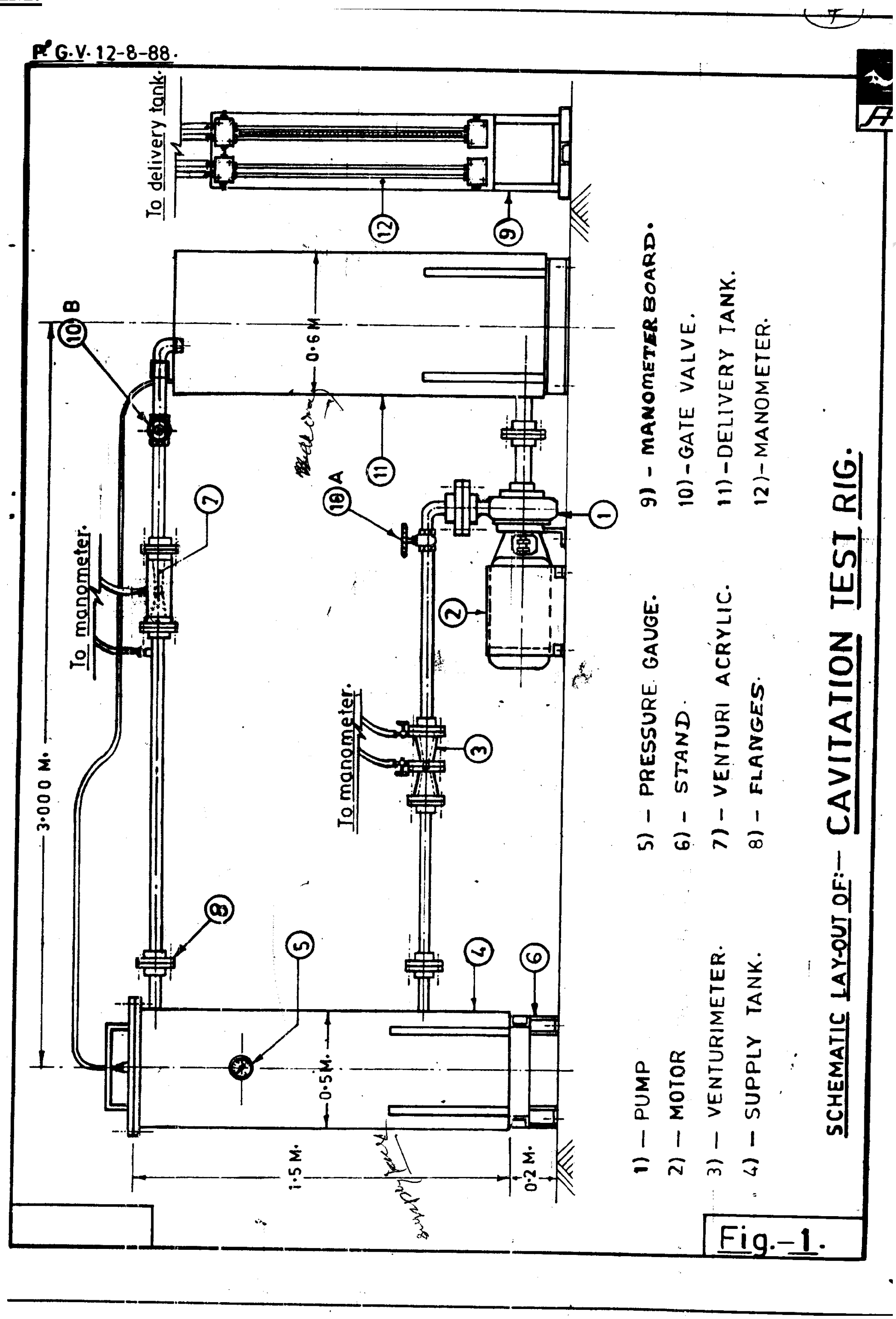
The cavitation could be controlled by controlling the pressure reduction and could be observed at various stages of its advancement.

DESCRIPTION:

This is a experimental setup with help of which cavitation could be initiated and controlled. The setup consist f following items: (See sketch)

1) The sump tank or delivery tank.
2) Centrifugal pump.
3) Venturimeter for discharge measurement.
4) Pressure tank.
5) Perspex Venturimeter to initiate cavitation.
6) Manometer for pressure measurement.
7) Pressure gauges.

DIAGRAM:


G.V. 12-8-88.
To delivery tank.
To manometer.
To manometer.
3·000 M.
0·6 M
0·5 M.
1·5 M.
0·2 M.
10 B
10 A
1) — PUMP
2) — MOTOR
3) — VENTURIMETER.
4) — SUPPLY TANK.
5) — PRESSURE GAUGE.
6) — STAND.
7) — VENTURI ACRYLIC.
8) — FLANGES.
9) — MANOMETER BOARD.
10) - GATE VALVE.
11) - DELIVERY TANK.
12) - MANOMETER.
SCHEMATIC LAY-OUT OF:- CAVITATION TEST RIG.
Fig.-1.

WORKING:

The test setup works as close circuit system and uses only above 750 liters of water as a cavitating fluid. Two tanks one as a sump of delivery tank and other as pressure tank is provided. The centrifugal pump sucks water. The delivery side of the pump is fitted with a valve for flow variation. A measurement Venturimeter provided for discharge measurement with pipe line. The discharge is given to a closed pressure vessel where the water gets pressurized and it passes through the Perspex Venturimeter and the same goes back to the sump tank through a suitable pipe line. The Perspex Venturimeter is so designed that the liquid reaches its vapor pressure at a desired discharge of water and cavitation is initiated at the throat and the pressure at throat is reduced to about 620 mm of Hg. (07 to 08 meters of water head). At this time the cavities could be observed around the throat area and they start travelling in the flow direction. After reaching a pressure zone they start collapsing and rattling sound could be heard.

OPERATION:

1. Fill water in the delivery tank (11) up to 1^{st} Ring marking from top. Keep the pump discharge valve (10 A) open at the time of filling as the pressure tank (4) shall also be filled up to that level.
2. Keep the valve (10A) slightly open and valve (10B) completely open and start the pump motor (1),.(2).
3. The water shall start flowing in the pressure tank (4) and through it in the bell mouth entry section (6) and the Perspex venture (7) back to the delivery tank (11).
4. Open the vent valves on manometers, Pressure tank

   Open pressure tapping valves on measurement Venturimeter (3) and remove air from the hose and close the overflow valves of respective manometer.
5. Adjust the discharge so s to get 5 to 7 cm mercury deflection in the measurement Manometer.
6. Now to remove air from the other manometer open the overflow valve and by applying back pressure with the help of valve (10B) remove air close the overflow valve on manometer.
7. Now open valve (10B) to its full range and then slowly increase discharge with the help of valve 10A.

   During this operation you shall feel that the cavitating has started due to following reasons but it may be a false indication.
   a) Air bubbles in the water passing through the venture.
   b) The obstruction due to the pressure tapping in the flow.
8. As soon as you reach a position when the pressure in the tank (4) is @0.3kg/cm^2 and you shall find that a ring of bubbles is seen at throat of the Perspex venture (7).
9. The deflection in the other manometer shall be @62 cm of Hg at this time. This is the right position of cavitation inception.

10. As you go on increasing the discharge the cavitation shall advance and no. of reading could be taken.

CALCULATIONS:

Discharge Measurement Venturimeter

Data:

1. Throat diameter = 3.9 cm. = Area a_2 = 11.94 cm^2
2. Inlet diameter = 6.5 cm. = Area a_1 = 33.16 cm^2
3. C_d. = 0.94
4. Water Head (h') = h(S-1) [S= 13.6 sp.gr. of mercury]

$$Q = C_{d.} \{a_1 . a_2 / (a_1^2 - a_2^2)^{1/2}\} \times \{(2gh)^{1/2}\}$$

Perspex Venturi

Data:

1. Inlet diameter (d_0)= 6.5 cm. = Area (a_0) = 33.16 cm^2
2. Throat diameter (d_t)= 2.6 cm. = Area (a_t) = 05.30 cm^2
3. Velocity at inlet (V_o) = Q/ a_0
4. Velocity head at inlet (V_o) = $V_o^2/ 2_g$

Cavitation Number:

$K = P_o - P_t / (V_o^2/2_g)$

P_0 = Pressure at inlet of Perspex venturi.

P_t = Pressure at throat of Perspex venturi.

Note: 760 mm of Hg = 1030 cm of water.

1 kg / cm^2 = 1030 cm of water head.

OBSERVATION TABLE:

Sr. No.	Measurement Venturi		Cavitation Venturi			$K = P_o - P_t/(V_o^2/2_g)$
	'h' cm of mercury	'Q' ccs / sec	Inlet Pressure (P_o)	Throat Pressure (P_t)	$V_o^2/2_g$	
01						
02						
03						
04						
05						
06						

EXPERIMENT NO: VI -

IMPACT OF JET APPARATUS

AIM: To find the coefficient of impact of jet for vane, 'K' (Stationary & Inclined).

APPARATUS:

1. Impact of Jet experimental Set up
2. Stopwatch

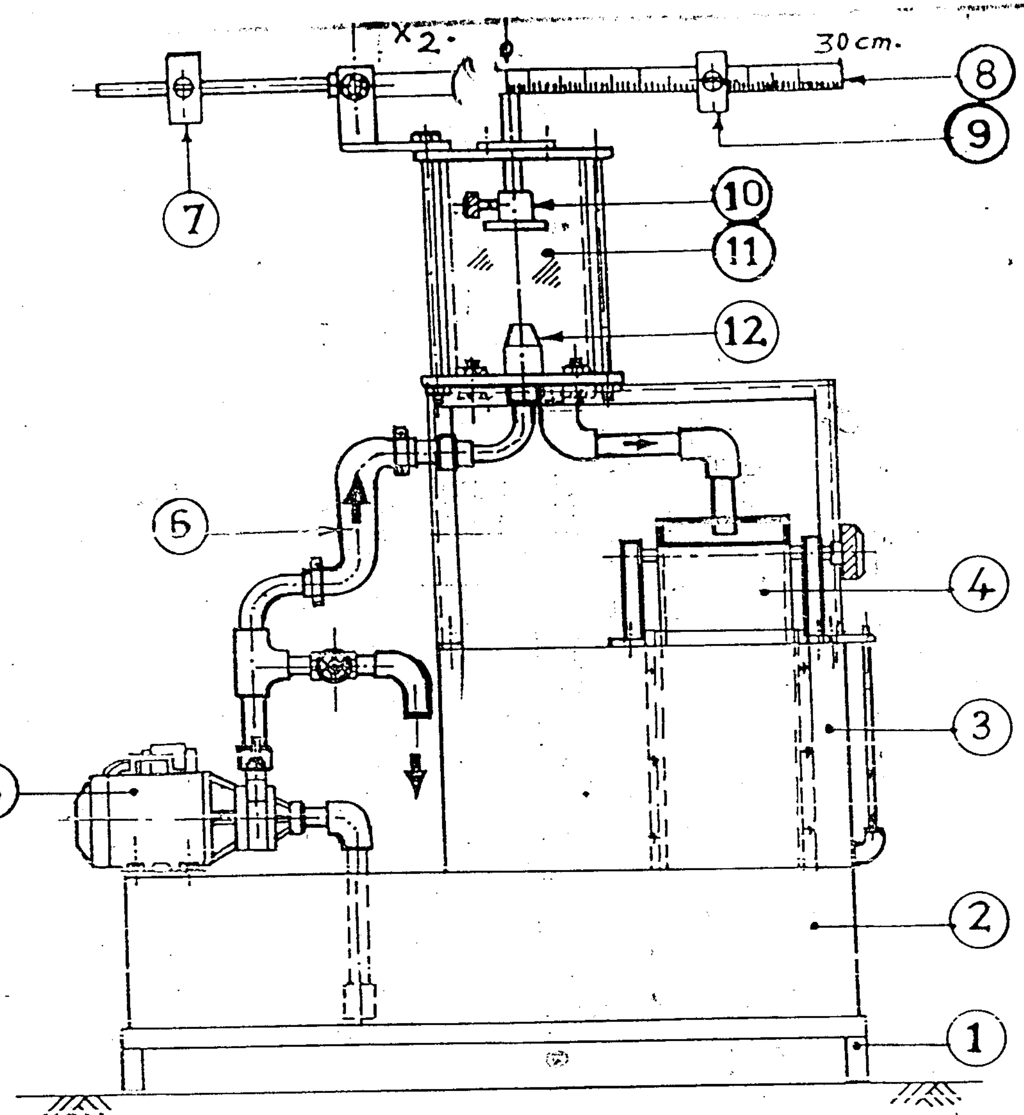
DESCRIPTION:

The apparatus consists of an Acrylic cylinder. At the center of the cylinder, a nozzle is provided. On the top of the cylinder, lever is provided for which fulcrum is given at one end. At another end of the lever, Balancing Weight is provided. On the lever, required vane is attached. A Movable Weight is provided on the scale to get lever balance. The discharge is led into the Measuring Tank.

PROCEDURE:

1. Fix a required vane (suppose a Flat Plate) to the lever.
2. Adjust the Balancing Weight so that the lever becomes horizontal.
3. Start the supply. The jet of water through the nozzle will impinge on the vane. The force due to impact of water will be acting on the vane in the upward direction. This will disturb the initial balance of the lever.
4. Suitably adjust the position of the Sliding (Movable) Weight, so that the lever becomes horizontal or takes the balanced position.
5. Adjust the Supply Valve and take few more readings / observations.
6. With different vanes attached, F, repeat the procedure.

G.V. – 3/9/95.



12).–Nozzle.
11).–Cylinder.
10).–Vane.
9).–Jokey weight.
8).–Scale.
7).–Balancing weight.
6).–Hose pipe.
5).–Water pump set.
4).–FUNNEL.
3).–Measuring Tank.
2).–Sump Tank.
1).–Base Frame.

SCHEMETIC LAY-OUT OF:–CLOSE CIRCUIT IMPACT OF JET APP.

FIG·1·

HYD.

OBSERVATIONS:

- Diameter of Nozzle = 1.0 cm ; A = 0.786 cm^2
- Distance X_2 cm = 14 cms
- Weight of Jockey (W_1) = 0.250 Kgs = 250 gms.
- Gravitational Constant (g) = 9.81 m/s^2

Sr. No.	X_1 cms	Time for 5 liters in Seconds	Displacement of Mass (X_1-X)	Discharge 'Q' in m^3/sec	(Actual Force) F_a in N	(Theoretical Force) F_t in N	Coefficient K= F_a/F_t
01							
02							
03							
04							
05							

RESULT:

- Average Coefficient of Impact of Jet for Stationary Vane($K_{STATIONARY}$) =………..
- Average Coefficient of Impact of Jet for Inclined Vane ($K_{INCLINED}$) =………..

EXPERIMENT NO: VII -

TO DETERMINE EFFICIENCY OF KAPLAN TURBINE TEST RIG (Closed Circuit)

AIM: To determine efficiency of Kaplan Turbine Test Rig.

INTRODUCTION

This test rig is meant for conducting experiments on model Kaplan Turbine. It has been specially designed to conduct experiments in Metric Units. The test rig consists essentially of (1) Kaplan Turbine; (2) A supply pump unit to supply water to the above Kaplan Turbine; (3) A flow measuring unit consisting of a Venturimeter and Manometer and (4) Piping system.

DESCRIPTION

The turbine consists of a spiral casing, an outer bearing pedestal and rotor assembly with runner, shaft and brake drum, all mounted on a suitable sturdy base plate. A straight conical draft tube is provided for the purpose of regaining the kinetic energy from the exit water and also facilitating easy accessibility of the turbine due to its location data higher level than the tail race. A transparent hollow Perspex cylinder is provided in between the draught bend and the casing for the purpose of observation of flow at exit of runner. A rope brake arrangement is provided to load the turbine. The output of the turbine can be controlled by adjusting the guide vanes for which a hand wheel and a suitable link mechanism by a pressure gauge and for the measurement of speed, use hand tachometer. (**PS : TACHOMETER NOT IN SCOPE OF SUPPLY**)

GENERAL SPECIFICATIONS

1. SPIRAL CASING : It is of close grained cast iron with integral legs and flanged inlet.
2. RUNNER : It is designed for efficient operation accurately machined and smoothly finished.
3. GUIDE VANE MECHANISM : It consists of guide vanes, operated by a hand wheel through a link mechanism.
4. SHAFT : It is of stainless steel accurately machined and provided with a bronze sleeve at the stuffing box.
5. BALL BEARINGS : It is of single row deep groove rigid type in the casing and single row self aligning type in the bearing pedestal both of liberal size.
6. DRAUGHT BEND : It is provided at the exit of the runner. To the bend is connected, a straight conical draught tube of mild steel fabrication of 500 length.
7. BRAKE ARRANGEMENT : It consists of a machined and polished MS brake drum, cooling water pipes, internal water scoop, discharge pipe, spring balance, rope brake etc. arranged for loading the turbine.
8. BASE PLATE : It is of MS Plate with heavy angle frame..
9. FINISH : It is of high standard suitable for laboratory use in technical institutions.
10. SUMP TANK : Size – 1200 L x 750 B x 600mm H,

    Capacity : 535Ltrs.(approx.)

SPECIFICATIONS

A) KAPLAN TURBINE : Out Put – 1 Kw

1. Rated Supply Head : 5 meters.
2. Discharge : 500 LPM
3. Rated Speed : 1000 rpm.
4. Power Input : 650 Watts.
5. No. of guide vanes : 10
7. Brake Drum Diameter : 270 mm.
8. Belt Thickness : 12mm. (Both sides)

B) SUPPLY PUMP SET

1. Rated Head : 12 meters.
2. Discharge : 550 LPM
3. Normal Speed : 2880 rpm.
4. Power Required : 5 HP
5. Size of Pump : 100 x 100mm.
6. Type … … … … : Centrifugal medium speed, single suction volute.
7. Brand & Model … : Kirloskar KDS – 515+, 440 VAC, 3 Phase.

C) FLOW MEASURING UNIT

1. Size of Venturimeter : ID : 155 mm ,
2. Venturimeter area Ratio : 0.69
3. Throat Diameter : 108 mm.
4. Manometer… … … : Double Column Differential Type with Mercury.
5. Meter constant for Venturimeter : K= 0.1614

(Q = K √ h)m^3 /sec.

Where 'h' is m of water.

D) BALL BEARING USED

1. In the casing … … : 6204 - 1 No.
2. In the bearing pedestal : 1204 - 1 No.

E) OIL SEALS USED

1. Shaft sealing … … : 25-35-7 - 2 Nos.
2. Guide Vane Seal … : 10-22-7 - 8 Nos.

F) Speed Measurement : Digital RPM Indicator with Proximity Sensor (Non Contact Type) Sensor Model : PNP type, M18 size.

INSTALLATION

In the Kaplan Turbine Test Rig, supply pump set is placed on the sump tank to draw the water and supply it to the turbine. The 100mm. Venturimeter and double column differential manometer arrangement are mounted on the Sump Tank. Pressure and vacuum gauge are situated near the turbine on the sump to measure the net supply head on the turbine.

The DOL starter with panel board and internal wiring arrangement are provided on this sump to supply pump-set.

A Pump is provided to the inlet of the Kaplan turbine to regulate the discharge and supply head on the turbine in relation to the guide vanes and runner blade settings. A set of ten guide vanes are provided around the periphery of the runner to control the load, the whole guide vane mechanism being operated through a hand wheel by suitable link mechanism.

PROCEDURE

The suction pipe with foot valve should be adequately submerged on the water. The flow measuring unit, Venturimeter and the differential manometer are so arranged and mounted that the readings can be conveniently taken. Make sure before starting that the pipelines are free from foreign matter also note whether all the joints are water tight and leak proof. Prime the pump and start it. While starting the guide vanes in the turbine shall be in the closed position. See that all the ball bearing and bush bearing in the unit are properly lubricated. A pressure and vacuum gauge is used to measure the supply head on the turbine. If the pump develop the rated head, slowly open the turbine guide vanes by rotating the hand wheel (which operates the guide vane through suitable mechanism) until the turbine attains the normal speed of 1850 rpm. Approx.. Run the turbine at the rated speed for about 15 minutes and carefully note the following :

a) Operation of the bearings, temperature rise, noise etc.
b) Vibration of the Unit.
c) Steady constant speed and fluctuation, if any.

In addition to this, on the pump side note operation of the stuffing box (the stuffing box should on occasional drip of water. If the gland is over tightened, the leakage stops, but the package will heated up and burn damage the shaft.).

If the operation of the above parts are normal, load the turbine slowly and take readings. To load the turbine, rotate the hand-wheel of circular balance. Open the water inlet valve and allow some cooling water through the brake drum when the turbine runs under load, so that the heat generated by the brake drum is carried by the cooling water. Don't suddenly load the turbine. Load the turbine gradually and at the same time open the guide vanes to run the turbine at normal speed.

TO SHUT DOWN

Before switching off the supply pump-set, first remove all load of brake drum. Slowly close the guide vanes to its full closed position. Manometer cocks should be closed in order to isolate the manometer. Switch off the supply to pump-set. **NEVER SWITCH OFF THE SUPPLY TO PUMP-SET WHEN THE TURBINE IS WORKING UNDER LOAD.** While the electric line trips off when the turbine is working, first unload the turbine, close all the cocks. Start the electric motor when the line gets the power and then operate the turbine, open the valves in the order said above.

TESTING

Water turbines are tested in the hydraulic laboratory to demonstrate how tests on small water turbine are carried out to study their construction and to give the students a clear knowledge about the different types of turbines and their characteristics.

The output power from the turbine is calculated from the reading taken on the brake drum and the speed of the shaft. The input power supplied to the turbine is calculated from the net supply head on the turbine and discharge through the turbine.

Efficiency of the turbine being ratio between the output and the input can be determined from these two readings.

The discharge is measured by the venturimeter and with the differential manometer. The supply head is measured with the help of pressure and vacuum gauge. The speed of the turbine is measured with a digital tachometer.

After starting and running the turbine at normal speed for some time load the turbine and take readings.

NOTE THE FOLLOWING

1. Net supply head.
2. Discharge.
3. Turbine shaft speed.
4. Spring balance readings - (S_1 & S_2.).

For any particular setting of the guide vanes, first run the turbine at light load and then gradually load it by rotating the hand-wheel, consisting of spring balance of 20 Kg. capacity. The net supply head on the turbine shall be maintained constant at the rated value, and this can be done by adjusting the gate valve fitted just before the turbine.

IMPORTANT FORMULA

Input Power (P_{in}) = γ x Q x H x 9.81 /1000 in Kw.

Where γ = Specific weight of water = 1000Kg/m^3

Q = Discharge in m^3/sec.

H = Supply head in meters

For Calculating Discharge = Q

1) Head over the turbine : -

Since 10 mtrs. Of water head corresponds to 1 Kg / cm^2

∴ H_1 = Pressure gauge reading (Kg / cm^2) x 10 Mtr

H_2 = Suction Vacuum X 12.6 Mtr.

Total head = $H_1 + H_2$Mtr.

2) Water flow rate: -

$$Q = Cd \times \frac{a_1 \times a_2}{\sqrt{a_1^2 - a_2^2}} \times (2gh_w)^{0.5} \quad m^3/sec$$

$$\mathbf{C} = Cd \times \frac{a_1 \times a_2}{\sqrt{a_1^2 - a_2^2}} \times (2 \times g)^{0.5}$$

$$C = 0.98 \times \frac{0.01886 \times 9.16 \times 10^{-3}}{[(0.01886)^2 - (9.16 \times 10^{-3})^2]^{0.5}} \times (2 \times 9.81 \times 12.6)^{0.5} = 0.1614$$

$$Q = 0.1614\,(hw)^{0.5} \quad m3/sec$$

Where,

a_1 = Inlet area of venturi = Dia. at inlet 0.155 m = 0.01886 … m^2

a_2 = Throat area of venturi = Dia. at throat - 0.108 m = 9.16 x 10^{-3} … m^2

C_d. = Co - efficient of discharge = 0.98

h_w = Manometer difference (h) mtr. = 12.6 x h

$$\text{Brake Power (OutPut)} = \frac{2\pi NT \times 9.81}{60000} \; \ldots \text{Kw}$$

$$\text{Efficiency } \eta = \frac{\text{Output (BP)}}{\text{Input } (P_{in})} \times 100$$

Where N = Turbine speed in RPM.

T = Torque in kgm , (effective radius of the brake drum in meters R x The net brake load in kg. (W)

Or T = R x Load in kg x 9.81 .Nm

R = 0.138 m.

OBSERVATION TABLE :

I) CONSTANT SPEED ... rpm (By Changing Guide Vane Positions)

Sr. No.	Spring Bal. reading – 'Kg'.			Mano. Diff.-h_w	Pr. Gauge	Vacuum Gauge rdg.	Guide Vane Position
	S1	S2	Net Load	'mm' of water	Kg/cm^2	'mm' of Hg.	

II) CONSTANT GUIDE VANE POSITION – By Changing Speed – Load Test.

Sr. No.	Guide Vane Position	Speed – 'rpm'	Spring Bal. reading – 'Kg'.			Mano. Diff.-h_w	Pr. Gauge	Vacuum Gauge rdg.
		N	S1	S2	Net Load	'mm' of water	Kg/cm^2	'mm' of Hg.

MAINTENANCE

As the unit is built very sturdily, it does not require any routine or regular maintenance. However, it is recommended that the following actions to be taken about once in a year to increase the life of the parts.

* Lubricate all the working parts where provision for lubricating is made. Grease cups are provided for lubrication ball bearings. Remove the grease drain plugs where fitted, and inject fresh grease through grease cups until waste grease along with a portion of fresh grease is ejected out through the grease drain hole. Then run the machine for a few minutes to eject the excess grease in the bearing housing. Then fit the grease drain plug.

* Clean the stuffing box, repack and lubricate it. If any packing rings is worn out, replace it with good quality as bets graphically packing. Tighten the gland nuts evenly and allow the stuffing box to drip water occasionally to lubricate the packing rings.

* Never run the pump without water in it as this would cause damage to stuffing box, bush bearings. Etc.

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Question Bank

FLUID MECHANICS & MACHINES (M)

Mahatma Gandhi Mission's
Jawaharlal Nehru Engineering College
Department of Mechanical Engineering
Fluid Mechanics and Machines (M)

Part A

1. Define fluid.
2. Differentiate between fluid and solid.
3. Define Specific volume
4. Define Specific gravity.
5. Define Viscosity.
6. Define Compressibility.
7. Define vapor pressure.
8. Define Capillarity.
9. Define Surface tension.
10. Differentiate between Absolute and gauge pressures.
11. Mention two pressure measuring instruments.
12. What is Piezometer?
13. How manometers are classified.
14. What is pitot static tube?
15. Write down the units for dynamic and kinematic viscosity.
16. State Newton's law of viscosity.
17. Differentiate between Newtonian and non Newtonian fluid.
18. Differentiate between ideal and real fluid.
19. What is ideal plastic fluid?
20. Define velocity gradient.
21. What is the difference weight density and mass density?
22. What is the difference between dynamic and kinematic viscosity?
23. Differentiate between specific weight and specific volume.
24. Define relative density.
25. What is vacuum pressure?
26. What is absolute zero pressure?
27. Write down the value of atmospheric pressure head in terms of water and Hg.
28. Define stream line.
29. Define path line.
30. Define streak line.
31. Define steady flow.
32. Define uniform flow.
33. Differentiate between laminar and turbulent flow.
34. How will you classify the flow as laminar and turbulent?
35. Differentiate between compressible and incompressible flow.
36. Differentiate between rotational and irrotational flow.
37. Define stream function.
38. Define velocity potential function.
39. Write down continuity equation for compressible and incompressible fluid.
40. Write down continuity equation in three dimensions.
41. Differentiate between local and convective acceleration.
42. Define circulation.
43. Define flow net.
44. Write down Euler's equation of motion.
45. Write down Bernoulli's equation of motion for ideal and real fluid.

46. State the assumptions made in Bernoulli’s equation of motion.
47. Mention the applications of Bernoulli’s equation of motion.
48. Mention few discharge measuring devices
49. Draw the Venturimeter and mention the parts.
50. Why the divergent cone is longer than convergent cone in Venturimeter?
51. Compare the merits and demerits of Venturimeter with orifice meter.
52. Why Cd value is high in Venturimeter than orifice meter?
53. What is the difference between Pitot tube and Pitot static tube?
54. What is orifice plate?
55. What do you mean by vena contracta?
56. Define coefficient of discharge.
57. Define coefficient of velocity.
58. Define coefficient of contraction.
59. State Buckingham’s Pi Theorem.
60. What is dimensional homogeneity?
61. What is dimensionless number?
62. Mention the methods for dimensional analysis.
63. Mention few important dimensionless numbers.
64. Mention the type of forces acting in moving fluid.
65. Define Reynold’s number.
66. Define Froude’s number.
67. Define Euler’s number.
68. Define Weber’s number.
69. Define Mach’s number.
70. What is the difference between model and prototype?
71. Mention two application of similarity laws
72. Define geometric similarity.
73. Define kinematic similarity.
74. Define dynamic similarity.
75. What is the difference between fluid kinematics and fluid dynamics?
76. Write down Hagen poiseulle's equation
77. Sketch the velocity distribution for laminar flow between parallel plates.
78. Sketch the shear stress distribution for laminar flow between parallel plates
79. Differentiate between Hydraulic Gradient line and Total Energy line.
80. Write down Darcy -weisback's equation.
81. Mention the application of moody diagram.
82. What is the difference between friction factor and coefficient of friction?
83. What do you mean by major energy loss?
84. List down the type of minor energy losses.
85. What is compound pipe?
86. What do you mean by equivalent pipe?
87. What is the condition for maximum efficiency of power transmission?
88. Define boundary layer thickness.
89. What do you mean by boundary layer separation?
90. Define displacement thickness.
91. Define energy thickness.
92. Define momentum thickness.
93. How boundary layers are classified?
94. Define laminar boundary layer
95. Define turbulent boundary layer.

96. Define laminar sub layer.
97. On what basis, the boundary layer is classified as laminar and turbulent?
98. Define drag force.
99. Define lift force.
100. Define turbine.
101. What are the classifications of turbine
102. Define impulse turbine.
103. Define reaction turbine.
104. Differentiate between impulse and reaction turbine.
105. What is the function of draft tube?
106. Define specific speed of turbine.
107. What are the main parameters in designing a Pelton wheel turbine?
108. What is breaking jet in Pelton wheel turbine?
109. What is the function of casing in Pelton turbine
110. Draw a simple sketch of Pelton wheel bucket.
111. What is the function of surge tank fixed to penstock in Pelton turbine?
112. How the inlet discharge is controlled in Pelton turbine?
113. What is water hammer?
114. What do you mean by head race?
115. What do you mean by tail race?
116. What is speed ratio?
117. What is flow ratio?
118. What is the difference between propeller and Kaplan turbine?
119. Mention the parts of Kaplan turbine.
120. Differentiate between inward and outward flow reaction turbine.
121. What is the difference between Francis turbine and Modern Francis turbine?
122. What is the difference between outward and inward flow turbine?
123. What is mixed flow reaction turbine? Give an example.
124. Why draft tube is not required in impulse turbine?
125. How turbines are classified based on head. Give example.
126. How turbines are classified based on flow. Give example
127. How turbines are classified based on working principle. Give example.
128. What does velocity triangle indicates?
129. Draw the velocity triangle for radial flow reaction turbine.
130. Draw the velocity triangle for tangential flow turbine.
131. Mention the type of characteristic curves for turbines.
132. How performance characteristic curves are drawn for turbine.
133. Mention the types of efficiencies calculated for turbine.
134. Define Hydraulic efficiency
135. Define Mechanical efficiency.
136. Define overall efficiency.
137. Define pump.
138. How pumps are classified?
139. Differentiate pump and turbine.
140. Define Rotodynamic pump.
141. Define Positive displacement pump.
142. Differentiate between Rotodynamic and positive displacement pump.
143. Define cavitation in pump.
144. What is the need for priming in pump?
145. Give examples for Rotodynamic pump

146. Give examples for Positive displacement pump.
147. Mention the parts of centrifugal pump.
148. Mention the type of casing used in centrifugal pump.
149. Why the foot valve is fitted with strainer?
150. Why the foot valve is a non return type valve?
151. Differentiate between volute casing and vortex casing.
152. What is the function of volute casing?
153. What is the function of guide vanes?
154. Why the vanes are curved radially backward?
155. What do you mean by relative velocity?
156. What is whirl velocity?
157. What do you mean by absolute velocity?
158. What is the function of impeller?
159. Mention the types of impeller used.
160. Mention the types of efficiencies calculated for pump.
161. Define Hydraulic efficiency
162. Define Mechanical efficiency.
163. Define overall efficiency
164. Define specific speed of pump.
165. Mention the type of characteristic curves for pump
166. How performance characteristic curves are drawn for pump.
167. Mention the parts of reciprocating pump.
168. What is the function of air vessel?
169. What is slip of reciprocating pump?
170. What is negative slip?
171. What is the condition for occurrence of negative slip?
172. What does indicator diagram indicates?
173. What is the difference between actual and ideal indicator diagram?
174. Briefly explain Gear pump.
175. Differentiate between internal gear pump and external gear pump.
176. Briefly explain vane pump.
177. What is rotary pump?
178. Draw the velocity triangle for centrifugal pump.
179. Draw the indicator diagram fro reciprocating pump.
180. What is the amount of work saved by air vessel?
181. Mention the merits and demerits of centrifugal pump.
182. Mention the merits and demerits of reciprocating pump.
183. What is separation in reciprocating pump?
184. How separation occurs in reciprocating pump?
185. Write down the equation for loss of head due to acceleration in reciprocating pump.
186. Write down the equation for loss of head due to friction in reciprocating pump.
187. Differentiate single acting and double acting reciprocating pump.

188. Define Gauge pressure.
189. Give the expression for Euler's Equations of motion.
190. What is Total energy line?
191. List few minor energy losses in a pipe line.

192. State Buckingham's π - theorem.
193. What is geometric similarity?
194. Define specific speed in a centrifugal pump.
195. What is jet ratio in a Pelton wheel?
196. What is indicator diagram in a centrifugal pump?
197. What is the use of air vessel in a pump?
198. Define fluid.
199. Differentiate between fluid and solid.
200. Define Specific volume
201. Define Specific gravity.
202. Define Viscosity.
203. Define Compressibility.
204. Define vapor pressure.
205. Define Capillarity.
206. Define Surface tension.
207. Differentiate between Absolute and gauge pressures.
208. Mention two pressure measuring instruments.
209. What is Piezometer?
210. How manometers are classified.
211. What is pitot static tube?
212. Write down the units for dynamic and kinematic viscosity.
213. State Newton's law of viscosity.
214. Differentiate between Newtonian and non Newtonian fluid.
215. Differentiate between ideal and real fluid.
216. What is ideal plastic fluid?
217. Define velocity gradient.
218. What is the difference weight density and mass density?
219. What is the difference between dynamic and kinematic viscosity?
220. Differentiate between specific weight and specific volume.
221. Define relative density.
222. What is vacuum pressure?
223. What is absolute zero pressure?
224. Write down the value of atmospheric pressure head in terms of water and Hg.

225. Define stream line.
226. Define path line.
227. Define streak line.
228. Define steady flow.
229. Define uniform flow.
230. Differentiate between laminar and turbulent flow.
231. How will you classify the flow as laminar and turbulent.
232. Differentiate between compressible and incompressible flow.
233. Differentiate between rotational and irrotational flow.
234. Define stream function.
235. Define velocity potential function.
236. Write down continuity equation for compressible and incompressible fluid.
237. Write down continuity equation in three dimensions.
238. Differentiate between local and convective acceleration.
239. Define circulation.
240. Define flow net.
241. Write down Euler's equation of motion.
242. Write down Bernoulli's equation of motion for ideal and real fluid.
243. State the assumptions made in Bernoulli's equation of motion.
244. Mention the applications of Bernoulli's equation of motion.
245. Mention few discharge measuring devices.

Part B QUESTIONS (Theory / Derivation)

1. Derive continuity equation in three dimension
2. Derive Bernoulli's equation from Euler's equation of motion.
3. Derive an expression for discharge in Venturimeter
4. Derive an expression for discharge in orifice meter
5. Derive Hagen poiseulle's equation for laminar flow through circular pipe.
6. Derive Darcy-weisback's equation for flow through pipes
7. Explain the types of similarities.
8. Derive an expression for specific speed for pump.
9. Derive an expression for specific speed for turbine.
10. Explain with neat sketch the working principle of Centrifugal pump
11. Explain with neat sketch the working principle of Reciprocating pump.
12. Explain with neat sketch the working principle of Pelton wheel turbine
13. Explain with neat sketch the working principle of Kaplan turbine
14. Explain with neat sketch the working principle of Reaction turbine
15. Explain with neat sketch the working principle of rotary pump(Gear / Vane pump)
16. Derive the efficiencies in centrifugal pump
17. Derive the amount of work saved by air vessel in reciprocating pump.

...All the Best...