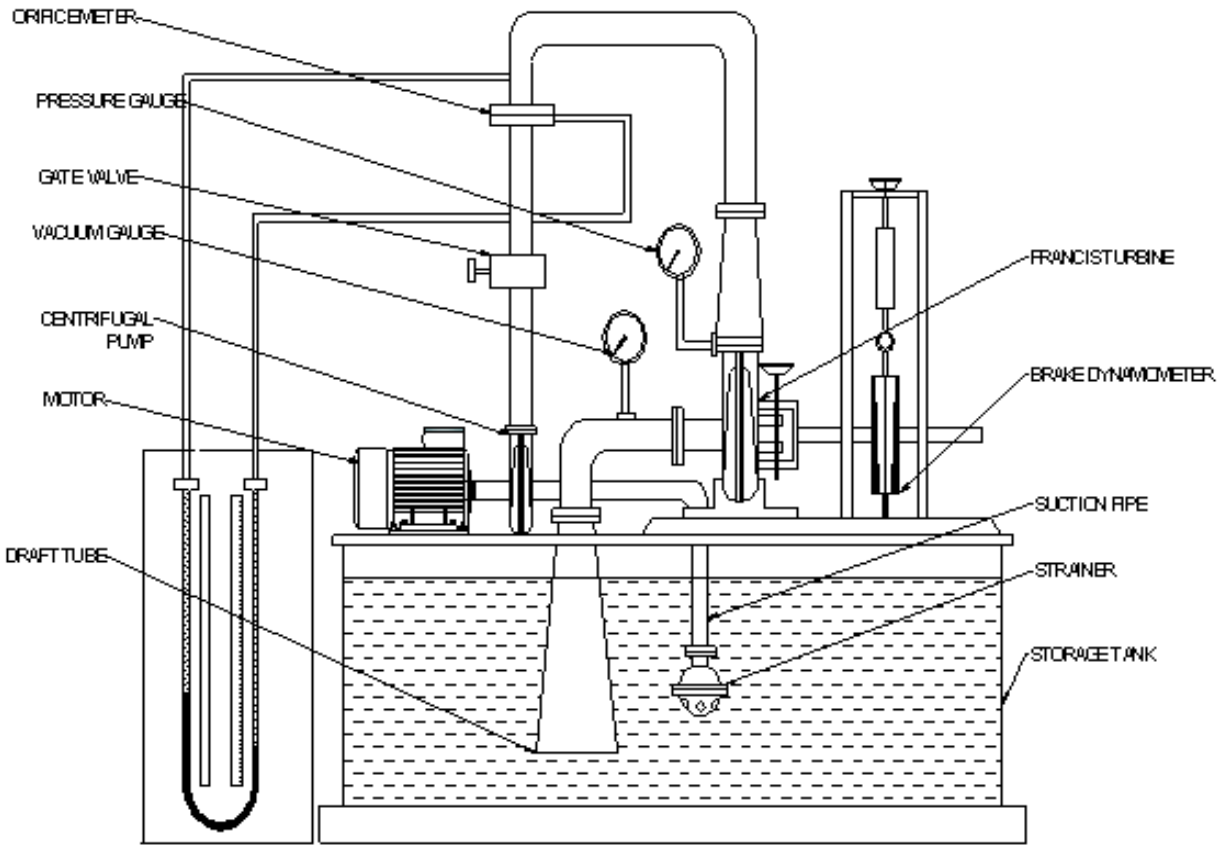
FRANCIS TURBINE



AIM :-To study the performance of Francis turbine and Plot Characteristic Curve.

APPARATUS :-1) Francis turbine
2) Tachometer
3) Vacuum Gauge
4) Pressure Gauge
5) Weight
6) Orifice meter
7) U-tube Manometer
8) Brake Dynamometer
9) Centrifugal Pump

TECHNICAL SECIFICATION :-

1) Francis Turbine

1) Supply Head	(H)	=	15	m
2) Discharge	(Q)	=	2000	LPM
3) Normal Speed	(N)	=	1250	RPM
4) Power Output	(P)	=	3.75	KW(5 H.P)
5)Runaway speed	(Nr)	=	2400	RPM
6) Runner diameter	(D)	=	160	mm
7) No. of Guide Vanes	(n)	=	10	Nos.
8) P.C.D. Guide Vanes	(D)	=	230	mm

2) Centrifugal Pump

1) Rated head	(H)	=	20	m
2) Discharge	(Q)	=	2000	LPM
3) Normal Speed	(N)	=	2880	RPM
4) Power Output	(P)	=	15	KW

3) Flow Measurement Unit (orifice meter)

1) Inlet diameter	(D1)	=	100	mm
2) Orifice diameter	(D2)	=	67.08	mm
3) Area ratio	(A2/A1)	=	0.45	
4) constant	(k)	=	0.0105	

4) Rope Brake Dynamometer

1) Brake drum diameter	(Dm)	=	300	mm
2) Rope diameter	(d)	=	15	mm

THEORY :- Francis turbine is a radial flow reaction turbine. It is operates under medium head and medium quantities of flow. It consists casing, runner with moving vanes , guide vanes, draft tube. Water is passing through the spiral casing and guide vanes a portion of the pressure head is converted into kinetic energy. The water enters the runner at a higher velocity than in pipe line.

EXPERIMENTAL SETUP:

Water under the pressure is supplied to turbine. The water is conveyed through a Orifice meter having manometer connection to determine the flow rate of water. Then water enters through the spiral casing into the guide vanes and then runner . The guide vanes can be rotated about their axis by means of hand wheel. Their position is indicated by pair of dummy guide vanes fixed outside the turbine casing.

The head of water is measured with the help of pressure gauge and vacuum gauge. The turbine shaft is coupled to a brake drum dynamometer to measure its power output.

PROCEDURE :-1) Prime the pump with water.

2) Open drum cooling water valve for cooling brake drum.

3) Adjust guide blades for 25 % opening .

4) Start the motor. Allow water to strike on buckets.

5) Note pressure gauge reading.

6) Load turbine by adding weight on hanger.

7) Note the manometer reading .

8) Note spring balance reading.

9) Measure turbine rpm using tachometer.

10) Repeat steps 7 to 9 for different weight.

11) Repeat steps 3 to10 for 50% ,75% and full gate opening.

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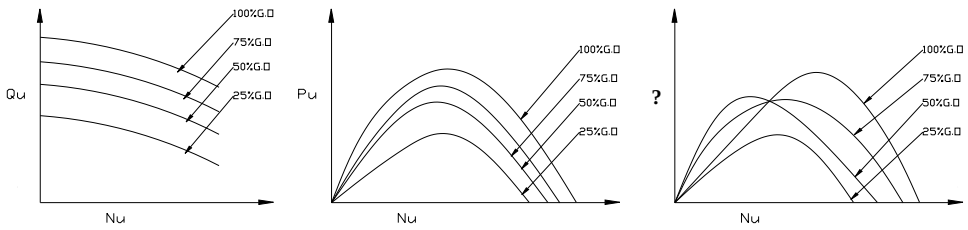
CHARACTERISTICS CURVES :

Draw the following characteristics of turbines.

1) Unit speed vs. unit discharge

2) Unit speed vs. unit power

3)Unit speed vs. efficiency



OBSERVATION TABLE:

Sr. no.	Pressure Gauge reading (H) Kg/cm2	Manometer Reading		Speed (N) RPM	Weight on Hanger (w1) Kg	Spring balance reading (w2) kg	Gate opening
		h1 cm	h2 cm				
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
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SAMPLE CALCULATION

1) Manometer difference in meters of water (h) =

$$= h1 - h2 \times \frac{Sh - Sw}{Sw}$$

Where

Sh = Specific gravity of mercury = 13.6

Sw = Specific gravity of water = 1

2) Discharge (Q) $= k.\sqrt{h}$

Where

K = Orifice meter constant = 0.0105

3)Input power (I.P.) = ρ x g x Q x H

Where

ρ = Density of water = 1000 kg/m^3

4) Output power (O.P.) = $\frac{2.\Pi.\ N.T}{60}$

Where

T = Torque = W x Re x 9.81

Where

W = Weight in kg = [(W1+Wh) - W2] =

Re = Effective radius of drum = (Dm/2)+d = 0.15+0.015= 0.165 m

Where

Wh = Weight of hanger = 1 Kg

Dm = Diameter of brake drum = 0.3 m

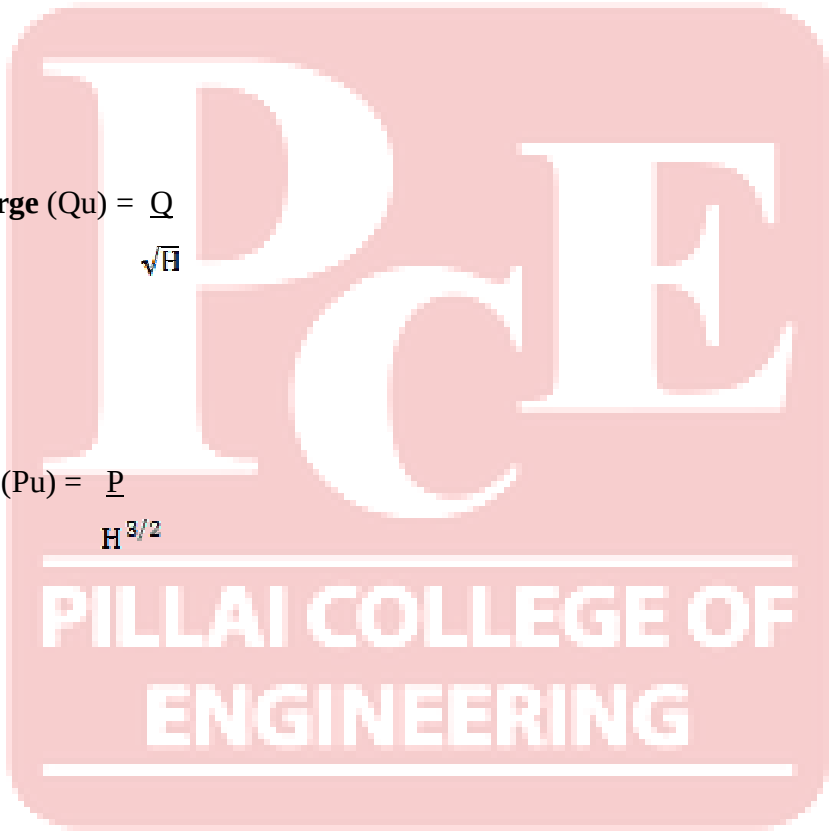
d = Diameter of rope = 0.015 m

5) Efficiency (η) = $\frac{\text{Output power}}{\text{Input power}}$

6) Unit speed (Nu) = $\frac{N}{\sqrt{H}}$

7) Unit discharge (Qu) = $\frac{Q}{\sqrt{H}}$

8) Unit power (Pu) = $\frac{P}{H^{3/2}}$



RESULT TABLE

Sr. No.	h (m)	H (m)	Q (m^3/s)	W (Kg)	I.P (W)	O.P (W)	η %	Nu	Qu	Pu
1										
2										
3										
4										
5										
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