ice County UNITED IN THE STATE OF STATE DIMENSIONAL & MODEL ANALYSIS Dimensional Analysis: It is a mathematical technique used in research were for design & for conducting model tests. Fixed Dimensions: Longth Latthraid sidemonist (a) Time. Fundamental dimensions: Fixed dimensions are called fundamental dimensions (or) fundamental quantity. and the same secondary (or) berived quantities: secondary (or) Desired quartities are those quantities which posses more than one fundamental dimensions. A Tolographic Countries and

120	5.44	physical Quantity	Symbo)	pimension
	9	(a) Fundamental	CONTRACTOR OF THE	
	1.	Longth	L	L
	2.	Mass	m M	M
offers	3.	Time		τ
	ruis	(b) Geometeric		4 Octo
	١.	Area	And	
	a.	volume	of war vi	in 3
		(c) kinematic Quantities	Post	A LANGE
	1.	velocity	N.	1.77
	2.	Angulax velocity	w	
		Acceleration	a	LT*
	L.	Discharge	a ·	L3 7-1
	5.	Accoloration Due to	den) incol	LT-2
and a	Office	Giravity	CUA describit	
	6.	kinomatic Viscosity		L2 7-1
		(d) Dynamic Quartilies	n Si litte	in E
	1.	Force.	F	MLT-&
	a.	weight	w	MLT-6
	3.	pensity	P	ML-3
	4.	specific weight	w	ML-2 T-2

10	5.NO.	Physical Quantity	Symbol 111	Dimensions		
1	51	Dynamic viscosity	μ	WL-17-\$		
	1.4	THE PROPERTY OF THE PARTY OF TH	ALL TO THE	-1 -2		
	6.	Pressure Intensity	P Instant	ML-1 T-2		
	7.	modulus of Elasticity		Mr - J-s		
	8.	swiface tension	6	MT-2		
	۹.	shear stress	T Survivia			
	10.	work , Energy	W (on) E	ML2 7-2		
	11.	Power	P	ML2 7-3		
	15	TOTANO	7	ML2 7-2		
	13.	momentum	M	MLT-)		
	E 560	Problems:				
	1)	petermine the dimension of the quanti- given below. i) Angular velocity ii) Angular Accelerat iii) Discharge iv) kinematic viscosity v) Fo vi) Specific weight vii) Dynamic viscosit				
	(F)2	angular velocity = $\frac{\text{Angle Coverad in model}}{\text{Time}}$				
		the state of the s	一十二十二			

Angular Accoleration = rad/sec²

=
$$\frac{rad}{T_2} = \frac{1}{T^2}$$

Angular Accoleration = T^{-2}

Angular Accoleration = T^{-2}

Fig. Discharge = T^{-2}

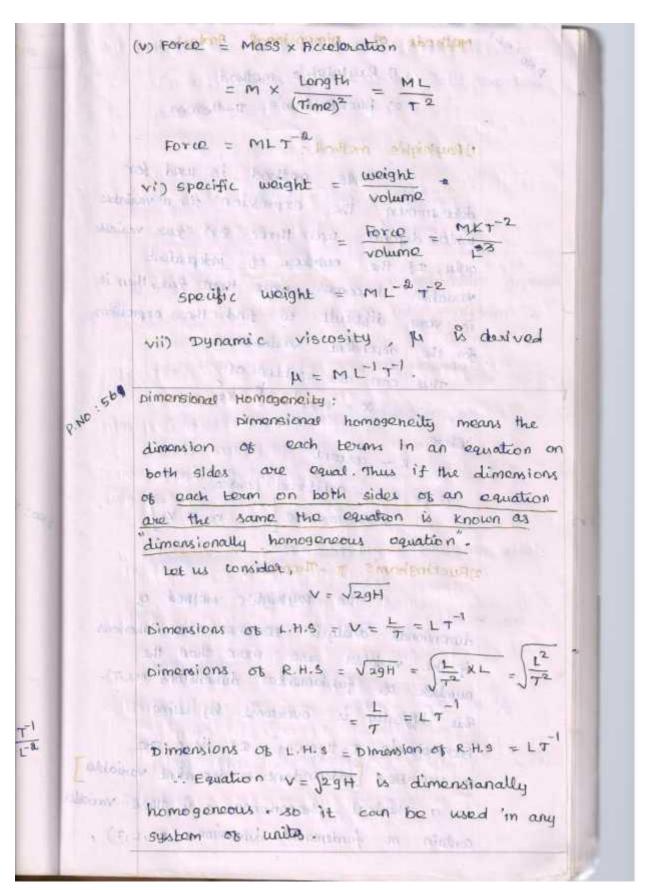
Discharge = T^{-2}
 T^{-2}
 T^{-2}

Discharge = T^{-2}
 T^{-2}
 T^{-2}

Discharge = T^{-2}
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Discharge = T^{-2}
 T^{-2}

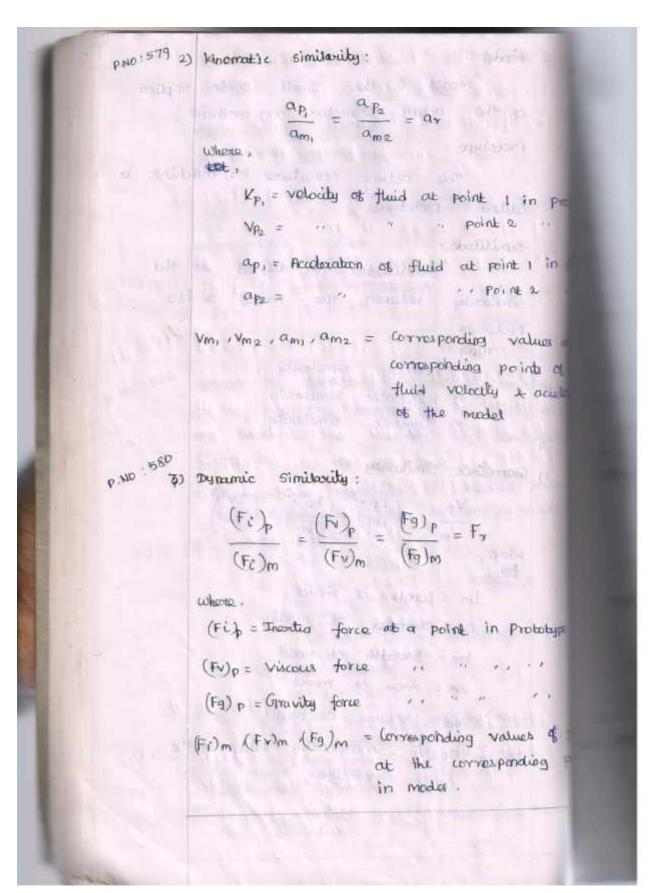


methods of dimensional Analysis: 1) Rayleigh's method 2) Buckingham's T-thorem 1) Rayleigh's method: Thes method is used for determining the expression for a variable which depends upon throse on four variable only, If the number of independent variables becomes more than four, then it is very difficult to find the expression for the dependent variables. This can also written as $X = K \times 1^{4} \cdot X_{2} \cdot X_{3}$ whose K - costant a ib & L - arbitrary powers. $x = \text{variable} \left[x, \cdot x_2 + x_3 \right]$ - Promoter 2) Bucking ham's Theorem: The payleigh's method of dimensional analysis becomes more laborious if the variables are more than the number of fundamental dimensions (M,L,T)-This difficulty is overcome by using "Buck inchands It - theorem". If there one n variables [independent & dependent variables in a physical phenomenon a if these vacin contain m fundamental dimension (M, L, T),

```
Then the variables are arranged into
  (n-m) dimension less terms. Each term is
  called " I - term".
           T1 = $ T2 / T3 . . . . In-m
\mathcal{X}_2 = \phi_1 \ \mathcal{X}_1 \cdot \mathcal{X}_3 \cdot \cdot \cdot \cdot \cdot \mathcal{X}_{0-m}
    and the second section and the best of the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a section in the second section in the section is a section in the section in the section in the section in the section is a section in the section is a section in the secti
 The time period (E) of a pendulum depends
  upon the length (1) of the pendulum +
 acceleration due to gravity (g). Derive an
 expression for the time poriod.
Time period t is a function of
  (1) L and (ii) 9
  homes be kind 96
 where, k is a constant
 substituting the dimensions on both sides
                              TI = KLa . (LT-2)b
  Equating the powers of M,L and T on
  both sides
Power of T, 1 = -2b : b = - 1/2
  Power of L, 0 = a+b : a = -b = -(-1/2)
the plant printed discount and our
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substituting the values of a and b in equation , and desired and the (man) F = K L The value of K is determined from experiments which given as, winds an adverte of his wintered on method of selecting Repeating vertiables: The number of repeating veries cone equal to the number of fundamental dimensions of the problem. 1 As for as possible, the dependant variant should not be solected as repeating unside Variable with i) Geomotia's property a) Lergth, 1 b) d c) Height ,H a) votocity ~ 6) Acceleration iii) fluid propody A) M 6) P 0) W The veperating variables selected should not form a dimension bes group. 1) The same number of fundamental dimensions. 3 No two repeating violable should have the same dimensions.

model: "model" is the small scale replica of the actual structure (or) machine. applied to Eliminate the defects Improve performance Prototype: The actual structure (or) machine is called Prototype. similitude: "similitude" is defined as the similarity between the modes Prototype. Typos : 1) Germeture similarity 2) Kinematic Similarity 3) Dynamic similarity Gamotric similarity: whome, lot, Im = Longth ob model Om = plameter of model bm = Breadth at model Am = Amea ot model Vm = Volume of model Le bp Dp . Vp = Comos ponding values of the prototype.

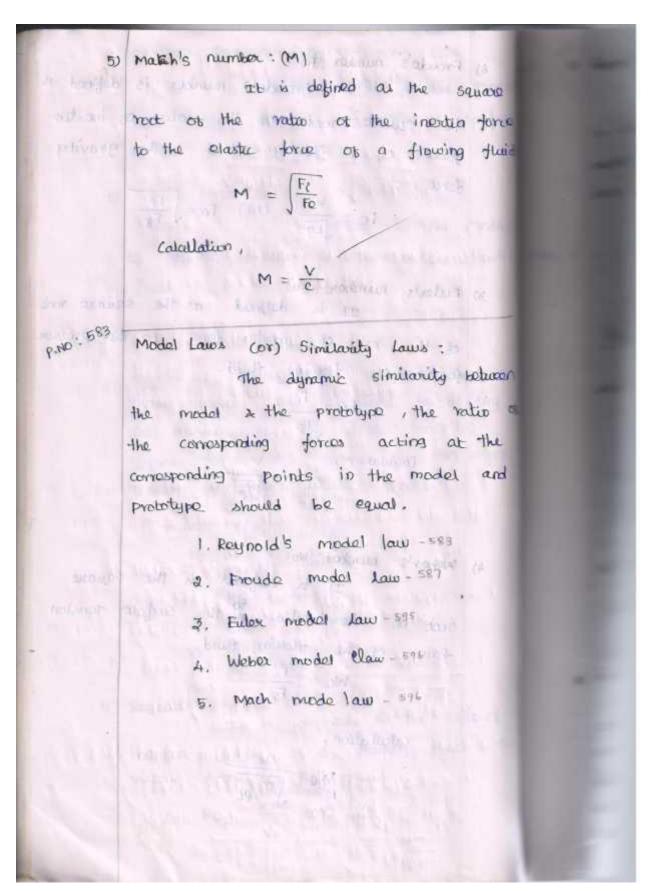


580 types of forces Acting in moving fluid: 1) Inertia force, Fe a) Viscous force , Fy 3) Gravity force, Fg 4) Pressure force Fp p) Swiface Tension force , Fs 6) Elastic force Fe . baut 1. Inentia force (Fi): It is equal to the product of mass & accoloration at the flowing fluid and acts in the direction opposite to the direction of accoleration. months force (m) forces done or budge a) Viscous force (fv): It is equal to the product of shear stress (t) due to viscosity and switacie avea ob the flow. 3) Gravity force (Fg): It is equal to the product of mass & accoloration due to gravity of the flowing fluid. Allowed allowed a and all to handlely to be 4) Prousure force (Fp): aqual to the product of Pressure intensity & cross-sectional area as the flowing fluid.

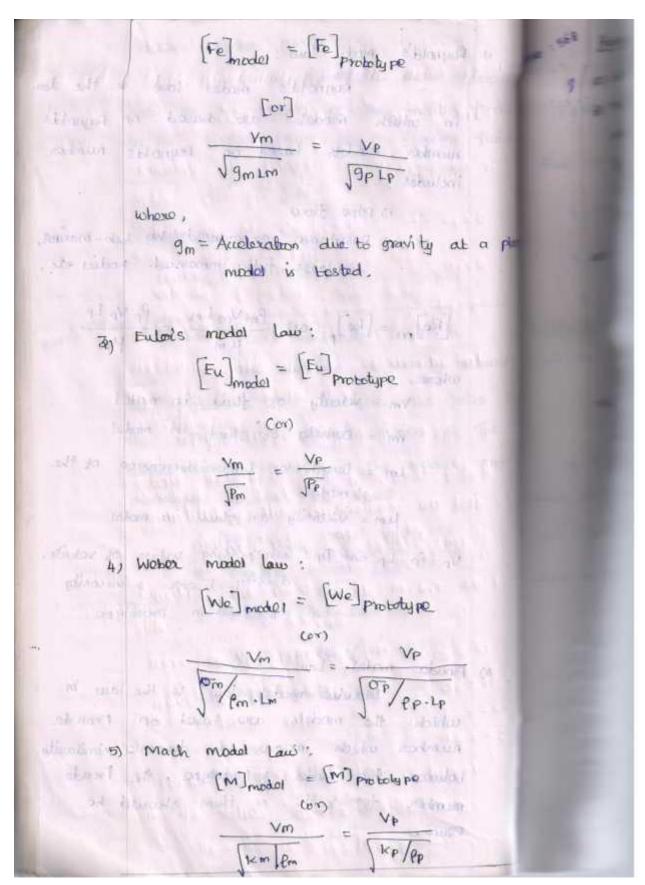
Swiface Tension Force (Fs): It is equal to the product of surface tension & length of surface of the flowing fluid. Exastic force (Fe): It is equal to the product of elastic stross & area of the Howing fluid . Dimensionless Numbers : Dimensionless numbers are those which are obtained by dividing the inertia force by viscous force los gravity force (or) Pressure force (or) surface tension force con Elastic force , 1) Reynold's number a) Froude's number 3) Euler's number 4) Weber's number 5) Mach's number Reynolds number:

It is defined as the valio of inertia force of a flowing fluid & th viscous force of the fluid. vxd con Pvd

	a) Froude's number: (Fo) of settings address to
15 800	The Froudo's number is defined as
163	the square root of the ratio of inertia
- East	force of a flowing fluid to the gravity
	force.
	For c
	the set here a present of the backlinders have minuted
	3) Euler's number: (Eu) It is defined as the square root
	of the rate of inortia force to the prossure
Otto	force of Howing Huid.
85 1	sides with a special side of the same side
M	the point of the boundaries with
bit	[alculate n , V
	Eu = $\frac{\sqrt{P/\rho}}{\sqrt{P/\rho}}$
	Attached Takene Takenest t
1	4) Wober's number: (No) It is defined as the square
	root of the value of the Surface tension
	root of the ratio of the surgare resistor
	-force of the flowing third.
183	$We = \sqrt{\frac{F_i^*}{F_S}}$
100	
	calculation,
	We = To /01
	The second secon
1	



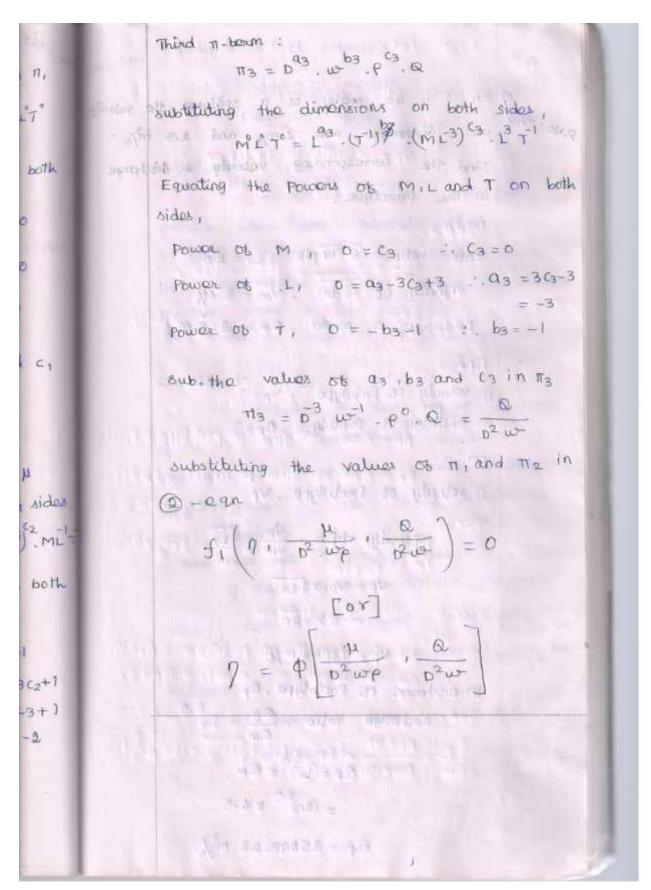
0	Reynold's model law:
	Reynold's mide law is the law
	in which models are based on Roynold's
	number. Models based on Reynold's number
	TWINDS TO THE TEXT OF THE PARTY
	includes :
	i) Pipe flow
	15 Resistance experienced by sub-marines,
	aixplanes, fully immossed bodies etc.
	[Re] m = [Re] p (or) Pm Vm Lm = Pp Vp Lp
	The state of the s
	vm = velocity of this in model
	Pm = ponsity of their in model
	Lm = Langth (on linear dimension of the
	hem = viscosity (or) theid in mode)
	Up. Pp. Lp and lip = Corresponding values of volority,
	density, linear & viscosity
	equitable of their in Prototype.
	Proude model Law:
*)	Froude model law is the law in
	which the models are based on Fronde
	number which means for dynamic similarity
	between the model & Prototype, the Froude
	number for both of them should be
	equal.



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Broblems: And The Angel
           a) State Buckingham's 11-theorem.
           to the officiency 9 of a fan depends on
              density e, dynamic viscosity 4 of the
       fluid , angular volocity w, diameter D of
              the notor & the discharge Q. Express p in
          turns of timensionals parameters.
a place
                D = 7(6 ' M' m' D' E)
          DO1:
                 (ro)
        f (p. P, H, W, D, Q) = 0 ->
             The total no of variables n = 6
              9 = Dimension less
       about the real model of 123 To 12 and 121 method
                   12 = p2 . w2 . p2 . pt
```

```
First 11-boxm:
           subs, dimensions on both Bides of 11,
 ML'T' = L (T) (ML3) . MLT
 Equating the Powers of M, L, T on both
All sides, probab sit & Jahn
         POWER OF M, 0= C,+0 , ----- C,=0
           Power of L 0 = 191+0 , ... 91=0
           Power of 7 0 = -b_1 + 0 2. b_1 = 0
         subtituting the values of a, b, and c,
         in T, , to the billion to be being a
         n_1 = p^0 \omega^2 \rho^0 \cdot \eta = m
          second \pi-beam: \pi_2 = 0^{a_2} \cdot w^{b_2} \cdot \rho^{c_2} \cdot \mu
          substituting the dimensions on both sid
                 M° L° T° = L a2. (T) b/2. (ML-3)2. ML
           Equating the powers of MILIT on both
          sides,
          Power of M, 0 = C_2 + 1 : C_2 = -1
           Power ob L, 0 = a_2 - 3c_2 - 1; a_2 = 3c_2 + 1
          Power ob t, 0 = - b2-1 : b2 = -1
          sub. the values as 1 be and ce in 1/2
             \pi_{\alpha} = \tilde{\alpha}^{\alpha} \cdot \tilde{\omega}^{-1} \cdot \tilde{\rho}^{-1} \cdot \tilde{\mu} = \tilde{\alpha}^{\alpha} \tilde{\omega}^{\alpha} \tilde{\rho}^{-1}
```



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s) In 1 in 40 model of a spillway, the velo and discharge are 2 m/s and 2.5 m/s Find the corresponding velocity & discharge in the prototype. conta: scale ratio of length, Lr = 40 velocity of model, vm = 2 m/s Discharge of model, om = 2.5 m3/s Find ; is velocity of Prototype , vp = ? ii) Discharge of Prototype, Op = ? 1) velocity of Prototype, VP velocity vatio , $\frac{V_P}{Vm} = V_{L_T}$ VP = Vm X TLY = a × 140 VP = 12.64 m/s 11) Discharge of Prototype, ap Discharge vatio, $\frac{Qp}{Qm} = Ly$ Qp = (L2) x Qm = (40)25 x 4.5 60p = 25298.22 m3/2

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700	No : 604 classification of models :
	1) Undistorted models
واه سلتع	a) Distorted models
	The state of the s
ge	1) Undistorted models:
- 1	"Undistorted models are those
- 1	models which are geometrically similar
- 1	to their Prototypes (or) in other words if
- 1	the scale ratio for the linear dimensions
- 1	to the model & its prototype is same,
- 1	the model is called "undistorted model".
	2) Distorted models:
-	A model is said to be distorted
	it is not geometrically similar to be
	Prototype. For a distorted model different
A.	scale ratios for the linear dimensions
	and adopted.
	edvantages of Distorted modes:
	is one ventical dimensions of the
	model can be measured accurately.
	a) The cost of the model can be.
	roduced.
denti *	3) Turbwant flow in the moder
10 = 19)	can be maintained.
	can be marked as
100	

scale Ratios for Distorted Models: 1. Scale ratio for velocity: Lot, Vp = velocity in Prototype vm = velocity in model Then; the Body to hold 2 scale ratio for area of flow, Let, and taken it Ap = Area ob How in Prototype = Bp xh Am = Ama of How in model = Bm x hm Thon. $\frac{B_P}{Bm} = \frac{B_P \times h_P}{Bm \times hm} = \frac{B_P}{Bm} \times \frac{h_P}{hm} = (1 \text{Tr})_H \times (1 \text{Tr})_V$ 3. scale ratio for discharge: let, Ep = Duchage Hough Prototype = ApxVp Om = Dischauge " model = Am x Vm Then, OF = HDX VP = (TI)H X(TI) X (TI) X (TI)A X (TI)H X (TI)H

