Techno India NJR Institute of Technology

Course File

Hydraulics Engineering (4CE4-06)

Session 2022-23

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SYLLABUS

II Year-IV Semester: B.Tech. (Civil Engineering)

4CE4-06: HYDRAULICS ENGINEERING

Credit: 3 **Max. Marks: 150 (IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hrs.
1	**Introduction:** to scope, objective and outcome of subject	1
2	**Dimensional Analysis & Models:** Dynamical Similarity and Dimensional Homogeneity Model experiment, geometric, Kinematic and Dynamic Reynold's, froudes, Weber's, Euler and Mach numbers. Distorted river models and undistorted models, proper choice of scale ratios. Scale effect. Principle of dimensional analysis Rayleigh method, Buckingham theorem.	4
3	**Turbulent flow** Reynoldequations, Prandtl's mixinlength theory, Equations of velocity distribution and friction coefficient **Boundary Layer Theory**: Concept of boundary layer, laminar and turbulent boundary layers, boundary layer thickness, von Karman integral equation, laminar sub-layer, hydro-dynamically smooth and rough boundaries, separation of flow and its control, cavitation.	6
4	**Open channel Flow** Uniform, Non-Uniform and variable flow. Resistance equations of Chezy and Manning. Section factor for uniform flow. Most Efficient rectangular, triangular and trapezoidal sections. Velocity distribution in open channels.	5
5	**Gradually varied flow** in Prismatic channels. Specific energy of flow. Critical depth in prismatic channels. Alternate depths. Rapid, critical and sub critical Flow Mild, steep and Critical Slopes. Classification of surface curves in prismatic channels and elementary computation	4
6	**Rapidly varied flow**: Hydraulic jump or standing wave in rectangular channels. Conjugate or sequent depths Losses in jump, location of jump. velocity distribution in open channels. Energy correction factor. Moment correction factor	4
7	**Impact of free Jets:** Impact of a jet on a flat or a curved vane, moving and stationary vane. **Introduction of Hydraulic machine** Type of pumps and turbine and its brief description. Draft tube and its principle	3

8	**Hydrology:** Definition, Hydrologic cycle, Application to Engineering problems, measurement ofrainfall, rain gauge, peak flow, flood frequency method, catchment area formulae, Floodhydrograph, Rainfall analysis, Infiltration, Run off, Unit hydrograph and its determination,Estimation of run off.	**8**
9	**Ground Water**: Aquifers and its types, Confined and unconfined aquifer, Darcy's Law, hydraulic conductivity, transmissivity, well hydraulics.	**3**
10	**Canal Hydraulics:** Types of canals, parts of canal irrigation system, channel alignment,assessment of water requirements, estimation of channel losses, design of channels, regime andsemi theoretical approaches (Kennedy's Theory, Lacey's Theory), cross section of channels, siltcontrol in canals.	**4**
	TOTAL	**42**

Course Overview:

Hydraulic engineering, as a sub-discipline of civil engineering, is concerned with the flow and conveyance of fluids. This course consists of the topic like viscous fluid flow, laminar and turbulent flow, boundary layer analysis, dimensional analysis, open channel flows, flow through pipes, and computational fluid dynamics. The objective of this course is to introduce various hydraulic engineering problems like open channel flows and hydraulic machines.

Hydraulic engineering is a sub-discipline of Civil Engineering. It deals with the flow of fluid, typically water and sewage conduits and uses the force of gravity for the movement of the same.It is used extensively in the construction of dams, bridges, canal, sewers etc. Hydraulic engineeringuses fluid mechanics as its foundation, to deal with problems of collection, storage, segregation, measurement, transport, control and use of water.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Comprehension	Students will be able to analyze the process of deriving equation byusing dimensional methods.
2	Analysis	Students will analyze the problems related to flow of fluids inchannel.
3	Synthesis	Students will be able to explain and remember the different typesof turbines & pumps used.
4	Synthesis	Student will be able to create economic sections for fluid channels.
5	Synthesis	Students will be able to remember the concepts of Hydrology.

Prerequisites:

- Student must have knowledge of basics of Fluid Mechanics.
- Students with basic knowledge of mathematical geometry can understand the topics clearly.
- Students with understanding of basic physics principle can grasp the topics of this course.
- Students with basic calculation methodologies can perform surveying calculations.

Course Outcome Mapping with Program Outcome:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
CO245.1	3	3	3	2	1	2	1	1	1	1	1	1	1	2	1
CO245.2	3	2	3	1	1	2	1	1	1	1	1	1	1	2	1
CO245.3	3	2	3	2	1	1	1	1	1	1	1	1	1	2	1
CO245.4	3	3	3	3	2	1	1	1	2	1	1	3	2	2	1
CO245.5	3	3	2	3	2	1	2	1	2	1	1	3	1	2	1
CO245 (AVG)	3	2.6	2.8	2.2	1.4	1.4	1.2	1	1.4	1	1	1.8	1.2	2	1

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	**1**	**INTRODUCTION:** Objective, scope and outcome of the course.
2	**2**	**DIMENSIONAL ANALYSIS & MODELS:** Dynamical similarity and dimensional homogeneity model experiment. Geometric, kinematic and dynamic similarity.
3	2	Reynold's, Froude's, Weber's, Euler and Mach numbers. Distorted river models and
4	2	Scale effect. Principle of dimensional analysis Rayleigh method.
5	2	Buckingham theorem
6	**3**	**TURBULENT FLOW:** Reynolds equations, Prandtl's mixing length theory
7	3	Equations of velocity distribution and friction coefficient.
8	3	**Boundary Layer Theory**: Concept of boundary layer, laminar and
9	3	Boundary layer thickness, Von Karman integral equation, laminar sub-layer.
10	3	Hydro-dynamically smooth and rough boundaries
11	3	Separation of flow and its control, cavitation.
12	4	**OPEN CHANNEL FLOW:** Uniform, Non-Uniform and variable flow, Resistance
13	4	Section factor for uniform flow. Most Efficient rectangular section
14	4	Most Efficient trapezoidal section and its numerical.
15	4	Most Efficient triangular section and its numerical.
16	4	Velocity distribution in open channels.

17	5	**GRADUALLY VARIED FLOW:** Specific energy of flow. Critical depth in prismatic
18	5	Numerical based on specific energy of flow
19	5	Rapid, critical and sub critical Flow Mild, steep and Critical Slopes.
20	5	Classification of surface curves in prismatic channels and elementary computation
21	6	**RAPIDLY VARIED FLOW:** Hydraulic jump or standing wave in rectangular Channels.
22	6	Conjugate or sequent depths, Losses in jump, location of jump.
23	6	Numerical based on above topics. Velocity distribution in open channels.
24	6	Energy correction factor. Moment correction factor
25	7	**IMPACT OF FREE JETS:** Impact of a jet on a flat or a curved vane, Moving and
26	7	**Introduction of Hydraulic machine:** Type of pumps and its brief description.
27	7	Type of turbine and its brief description. Draft tube and its principle
28	8	**HYDROLOGY:** Definition, Hydrologic cycle, Application to Engineering problems
29	8	Measurement of rainfall, rain gauge.
30	8	Peak flow, flood frequency method.
31	8	Catchment area formulae, Flood hydrograph.
32	8	Rainfall analysis, Infiltration, Run off.
33	8	Numerical based on above topics.
34	8	Unit hydrograph and its determination
35	8	Estimation of run off.
36	9	**GROUND WATER:** Aquifers and its types, Confined and unconfined aquifer
37	9	Darcy's Law, hydraulic conductivity
38	9	Transmissivity, well hydraulics and numerical.
39	10	CANAL HYDRAULICS: Types of canals, parts of canal irrigation system, Channel
40	10	Assessment of water requirements. Estimation of channel losses and Numerical.
41	10	Design of channels, regime and semi theoretical approaches (Kennedy's Theory)
42	10	Design of channels, regime and semi theoretical approaches (Lacey's Theory), Cross

TEXT/REFERENCE BOOKS

1. Fluid Mechanics & Hydraulics by Dr. K.R, Arora, Standard Publishers & Distributers, Delhi.
2. Fluid Mechanics & Hydraulics by Dr. R.K. Bansal, Laxmi Publications (P) Ltd.
3. Fluid Mechanics & Hydraulics by Modi & Seth, Standard Publishers & Distributers, Delhi.
4. Fluid Mechanics & Machinery by C.S.P.Ojha, R.Berndtsson and P.N. Chandramauli, Oxford Publishers, Delhi.

Course Level Problems (Test Items):

CO.NO.	Problem description
1	1) Explain the types of flows in open channel. 2) Discuss the concept of alternate depths and critical depths. 3) Explain the concept of most economic section for open channel flow.
2	4) Write and explain working of turbines. 5) Explain the concept of specific speed of pumps and turbines. 6) Discuss the types of turbines used with their application areas.
3	7) Explain the types of dimensional methods. 8) State what is Buckingham's Pi Theorem.

Assessment Methodology:

1. Practical exam in lab where they have to analyze the problem statement. (Once in a week)
2. Assignments one from each unit.
3. Midterm subjective paper based on topics as mentioned in the modules. (Twice during the semester)
4. Final paper at the end of the semester subjective.

TEACHING AND LEARNING RESOURCES UNIT-WISE

1. NPTEL Hydraulics Engineering Lecture Link:

https://nptel.ac.in/courses/105/105/105105203/

2. Buckingham's Pi-Theorem:

https://en.wikipedia.org/wiki/Buckingham_%CF%80_theorem

3. Rayleigh's Theorem:

https://en.wikipedia.org/wiki/Rayleigh%27s_method_of_dimensional_analysis#:~:text=Rayleigh's%20method%20of%20dimensional%20analysis%20is%20a%20conceptual%20tool%20used,was%20named%20after%20Lord%20Rayleigh.

4. Most Economical Section:

https://unacademy.com/lesson/most-efficient-triangular-and-circular-channel-sections-hydraulics-engineering-in-hindi/RKEGX1TS

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY

SUBJECT: HYDRAULICS ENGINEERING

Faculty Name: Jitendra Choubisa

TUTORIAL SHEET – 01

MARKS-30 DUE DATE: **01/June/2022**

Each question carries equal marks

Q1. Explain Buckingham Pi theorem with example.

Q2. What do you understand by Dimensional Homogeneity? Explain with example.

Q3. State what Dimensionless number are and explain each of them.

Note: Attempt all of the above questions and make a clear pdf and upload on google classroom's specific assignment before the due date.

TECHNO INDIA NJR
INSTITUTE OF TECHNOLOGY

SUBJECT: HYDRAULICS ENGINEERING

Faculty Name: Jitendra Choubisa

TUTORIAL SHEET – 02

MARKS-30 DUE DATE: **05/June/2022**

Each question carries equal marks

Q1. *(b) The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D of the rotor and the discharge Q. Express η in terms of dimensionless parameters.*

Q2. Explain what the types of similarities considered in Model analysis are?

Q3.

Problem 12.15 *A pipe of diameter 1.5 m is required to transport an oil of sp. gr. 0.90 and viscosity 3×10^{-2} poise at the rate of 3000 litre/s. Tests were conducted on a 15 cm diameter pipe using water at 20°C. Find the velocity and rate of flow in the model. Viscosity of water at 20°C = 0.01 poise.*

Note: Attempt all of the above questions and make a clear pdf and upload on google classroom's specific assignment before the due date.

TECHNO INDIA NJR
INSTITUTE OF TECHNOLOGY

SUBJECT: HYDRAULICS ENGINEERING

Faculty Name: Jitendra Choubisa

TUTORIAL SHEET – 03

MARKS-30 DUE DATE: **10/June/2022**

Each question carries equal marks

Q1. Explain Reynold's experiment for turbulent flow.

Q2. Derive the formulae for loss of head due to friction in pipes.

Q3. Write about Shear Stress in turbulent flow.

Note: Attempt all of the above questions and make a clear pdf and upload on google classroom's specific assignment before the due date.

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR

B. TECH 2nd – YEAR (IV SEM.) – MT-I

HYDRAULICS ENGINEERING (**4CE4-06**)

Time: 2 Hr **Max. Marks:** 70

Note:

1) The paper is divided into 2 parts: Part-A and, Part-B.
2) Part-A contains 10 questions and carries 2 mark each.
3) Part-B contains 5 questions. Each question is having two options and carries 10 marks each.

Part- A (20 Marks)

A.	Explain Fundamental Dimensions.	CO1
B.	Explain what is Modal Analysis?	CO1
C.	What do you understand by dynamic Similarity?	CO1
D.	What do you mean by Dimensionless Number?	CO1
E.	What do you mean by a Most Economical Section?	CO2
F.	Explain Reynold number for open channel flow with formulae.	CO2
G.	What hydro-dynamically smooth boundary means?	CO2
H.	What laminar & turbulent flow means.	CO2
I.	Write chezy's formula and explain its terms.	CO3
J.	Write condition for most economic rectangular section.	CO3

Part- B (50 Marks)

1. The efficiency η of a fan depends upon density ρ, dynamic viscosity μ, angular velocity ω, diameter D of the rotor and discharge Q. Express η in terms of dimensional parameters. (Take D, ω, ρ as repeating variable).	CO1
OR	
1. Define what Rayleigh's method of dimensional analysis is. The time period (t) of a pendulum depends upon the length (L) of the pendulum and acceleration due to gravity (g). Derive the expression for the time period.	CO1

2. What do you mean by Dimensionless numbers? Write any 4 dimensionless number with their respective formulas and their applications.	CO1
OR	
2. Write down the types of similarity in modal analysis. Explain the types of forces present in a fluid flow with their respective formulas.	CO1

3. Derive the condition for most economical trapezoidal channel section.	CO2
OR	
3. Find the bed slope of trapezoidal channel of bed 4 m, depth of water 3 m and side slope of 2 horizontal to 3 vertical, when the discharge through the channel is $20 m^3/s$. Take manning's constant N = 0.03.	CO2

4. What do you mean by Boundary layer flow? Explain the terms laminar boundary layer, turbulent layer & laminar sub-layer with diagram.	CO2

OR	
4. What do you understand by Hydro dynamically smooth and rough boundaries?	CO2

5. Write what are the types of flow in channel. Explain the chezy's formulae for the friction losses in pipe.	CO3
OR	
5. Explain the turbulent flow by Prandtl's mixing length theory.	CO3

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY, UDAIPUR

B. TECH 2nd – YEAR (IV SEM.) – MT-II

HYDRAULICS ENGINEERING (**4CE4-06**)

Time: 2 Hr **Max. Marks:** 70

Note:

4) The paper is divided into 2 parts: Part-A and, Part-B.
5) Part-A contains 10 questions and carries 2 mark each.
6) Part-B contains 5 questions. Each question is having two options and carries 10 marks each.

Part- A (20 Marks)

K.	Explain what steady and Uniform flow types are?	CO3
L.	Write what is a Laminar Flow.	CO3
M.	Explain Critical, Sub critical and Super critical flow.	CO3
N.	Explain what a chezy's formula is.	CO3
O.	What makes a section most economical?	CO4
P.	Explain specific energy.	CO4
Q.	What do you understand by Hydraulic jump?	CO4
R.	Explain what draft tube is.	CO4
S.	What do you understand by rain gauge?	CO5
T.	What is a contour canal?	CO5

Part- B (50 Marks)

2. Derive the formula for discharge through open channel by Chezy's Formula.	CO3
OR	
6. A flow of water of 150 liters per second flows down in a rectangular flume of width 700 mm and having adjustable bottom slope. If Chezy's constant C is 60, find the bottom slope necessary for uniform flow with a depth of flow of 400 mm.	CO3

7. Derive the condition for most economical trapezoidal channel section.	CO3
OR	
2. A rectangular channel carries water at the rate of 400 liters/s when bed slope is 1 in 2000. Find the most economical dimensions of the channel if C = 50.	CO3

8. What do you understand by specific energy and explain specific energy curve.	CO4
OR	
3. Explain critical depth, critical velocity with their respective formulas.	CO4

9. Derive conditions for maximum discharge for a given value of specific energy.	CO4
OR	
4. Derive expression for depth of hydraulic jump.	CO4

10. Explain various types of Rain gauges used in Hydrology.	CO5

OR	
5. A channel section has to be designed for the following data : Discharge Q = 30 cumecs Silt factor f = 1.00 Side slope ½ : 1 Find also the longitudinal slope.	CO5

MULITPLE CHOICE QUESTIONS

1. A pitot tube is used to measure
   - pressure
   - difference in pressure
   - velocity of flow
   - None of these.

2. The thickness of a sharp crested weir is kept less than
   - one-third of the height of water on the sill
   - one-half of the height of water on the sill
   - one-fourth of the height of water on the sill
   - two-third of the height of water on the sill
   - None of these.

3. The property of steam function ψ is:
   - ψ is constant everywhere on any stream line
   - the flow around any path in the fluid is zero for continuous flow
   - the rate of change of ψ with distance in an arbitrary direction, is proportional to the component of velocity normal to that direction
   - the velocity vector may be found by differentiating the stream function
   - All the above.

4. The maximum vacuum created at the summit of a syphon is
   - 1 m of water
   - 7.4 m of water
   - 5.5 m of water
   - None.

5. If the atmospheric pressure on the surface of an oil tank (sp. gr. 0.8) is 0.1 kg/cm2, the pressure at a depth of 2.5 m, is
   - 1 metre of water
   - 2 metres of water
   - 3 metres of water
   - 3.5 metres of water
   - 4.0 metres of water.

6. The total pressure force on a plane area is equal to the area multiplied by the intensity of pressure at its centroid, if
   - area is horizontal
   - area is vertical
   - area is inclined
   - All the above.

7. If the volume of a liquid weighing 3000 kg is 4 cubic metres, 0.75 is its
   - specific weight
   - specific mass
   - specific gravity
   - None of these.

8. Bernoulli's equation assumes that
   - fluid is non-viscous
   - fluid is homogeneous
   - flow is steady
   - flow is along the stream line
   - All the above.

10. A syphon is used
   - to connect water reservoirs at different levels intervened by a hill
   - to supply water to a town from higher level to lower level
   - to fill up a tank with water at higher level from a lower level
   - None of these.

4E 2034

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4E 2034

B. Tech. IV Semester (Back/Old Back) Examination - 2012

Civil Engineering

4CE3 Hydraulics and Hydraulic Machines

Time : 3 Hours

Maximum Marks : 80

Min Passing Marks : 24

Instructions to Candidates:

*Attempt any **Five questions** selecting **one question** from **each unit**. All questions carry **equal marks**. (Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly.) Units of quantities used/ calculated must be stated clearly.*

Unit - I

1. a) State Buckingham's π-theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional analysis. **(10)**

   b) Derive expressions for any two dimensionless numbers. **(6)**

OR

1. a) A 1:15 model of a flying boat is towed through water. The prototypes is moving in sea water of specific weight 1024 kg/m^3 at a velocity of 20m/sec. Find the corresponding speed of the model. Also determine the resistance due to waves on model if the resistance due to waves of prototype is 6000N. **(10)**

   b) What are the various types of similarities. Are these similarities truly attainable? If not why? **(6)**

Unit - II

2. Prove that the velocity distribution for viscous flow between two parallel plates when both plates are fixed across a section is parabolic in nature. Also prove that maximum velocity is equal to one and half times the average velocity. **(16)**

OR

2. Derive an expression for shear stress due prandte. What do you mean by Prandte mixing length theory. Also how would you distinguish between hydrodynamically smooth and rough boundaries. **(6+6+4=16)**

Unit - III

3. a) Derive the differential equations for steady gradually varied flow in an open channel and list all assumptions. **(10)**

$$\frac{dh}{dx} = \frac{(i_b - i_e)}{(1 - F_e^2)}$$

b) Explain the terms (i) slope of the bed (ii) Hydraulic mean depth (iii) wetted perimeter. **(6)**

OR

3. a) A trapezoidal channel with side slopes of 1 to 1 has to be designed to convey 10 m^3/sec. at a velocity of 2m/sec. So that the amount of concrete lining for the bed and sides is the minimum. Calculate the area of lining required for one metre length of canal. **(10)**

b) Explain the terms

i) specific energy of a flowing fluid

ii) critical depth

iii) and critical velocity as applied to non uniform flow. **(6)**

Unit - IV

4. What do you mean by hydraulic jump. Derive expressions for the depth of hydraulic jump and loss of energy due to hydraulic jump. **(16)**

OR

4. A 7.5 cm diameter jet having a velocity of 30 m/sec. Strikes a flat plate, the normal of which is inclined at 45^0 to the axis of the jet. Find the normal force on the plate.

i) When the plate is stationary and

ii) When the plate is moving with a velocity of 15 m/sec and away from the jet.

Also determine the horse power and the efficiency of the jet when the plate is moving. **(6+6+2+2=16)**

Unit - V

5. Differentiate followings in respect to turbines

a. Gross head and net head

b. Impulse turbine and reaction turbine.

c. Specific speed and unit speed

d. Speed ratio and flow ratio

e. Draft tube and pen stock

f. Turbine and pump

g. Cavitation and watter hammer

h. Hydraulic efficiency and mechanical efficiency. **(2x8=16)**

OR

5. a) Obtain an expression for the workdone by impeller of a centrifugal pump on water per second per unit weight of water.

b) Obtain an expression for the minimum speed for starting a centrifugal pump. **(8+8=16)**

4E4113

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4E4113

B. Tech. IV-Sem. (Main & Back) Exam; April-May 2017

Civil Engineering

4CE3A : Hydraulics & Hydraulic Machines

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 26

Instructions to Candidates :-

*Attempt any **five questions**, selecting **one question** from **each unit**. All Questions carry **equal** marks. Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly.*
Units of quantities used / calculated must be stated clearly.
Use of following supporting material is permitted during examination.
(Mentioned in form No. 205)

1. NIL 2. NIL

UNIT - I

1 Water flowing under an obstacle is shown in Fig.1 below. The flow exerts a vertical force on an object, which is assumed to be function of flow rate, density of water, acceleration of gravity and the length of object. A 1/20 scale model is to be used to predict the vertical force on the prototype.

(a) Use Banckingham π theorem to obtain π terms.

(b) If the model force is 100 N, predict the corresponding force in prototype.

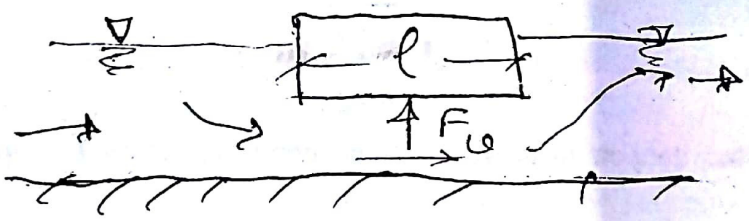

Fig. 1

16

OR

1 (a) What is law of dimensional homogeneity ? 3

(b) Oil of kinematic viscosity 4.65×10^{-5} m^2/s is to be used in a prototype in which both viscous and gravity forces dominate. A model scale of 1:5 is also desired. What viscosity of model liquid is necessary to make both Froude No. and Reynold No. the same in model and prototype ? 13

UNIT - II

2 (a) Derive the equation for velocity distribution in a circular pipe. 6

(b) An oil of viscosity 9 poise and specific gravity 0.8 is flowing through a horizontal pipe of 50 mm diameter. If the pressure drop in 100 m length of pipe is 1600 kN/m^2; determine

(a) Rate of flow of oil

(b) Centre line velocity. 10

OR

2 (a) Briefly describe different theories of turbulence. 10

(b) Derive equation for velocity distribution for turbulent flow in pipes. 6

UNIT - III

3 (a) What do you mean by most economical section for open channel ? 3

(b) Derive conditions for most economical trapezoidal channel section. 13

3 (a) What are assumptions taken to derive equation for gradually varied flow in open channel ?

6

(b) Find the slope of the free water surface in a rectangular channel of width 20 m. having depth of flow 5m. The discharge through the channel is 60 m^3/s. The bed of channel is having slope of 1 in 4000. Take value of Chezy's const. C = 60.

10

UNIT - IV

4 (a) What are uses of hydraulic jump ?

6

(b) A 4m wide rectangular channel conveys 15 m^3/s of water with a velocity of 5 m/s. Check is there a condition for hydraulic jump to occur. If the hydraulic jump takes place in down stream side, find the depth of flow after the jump.

10

OR

4 With neat sketches draw the velocity triangle at inlet and outlet of an unsymmetrical moving curved plate when jet strikes tangentially at one of its end. Define all terms used in triangles.

16

UNIT - V

5 The power plant installation is shown in Fig. 2 below. Water passes through turbine and goes downstream. Determine power available to the turbine when the flow rate is 30 m^3/s.

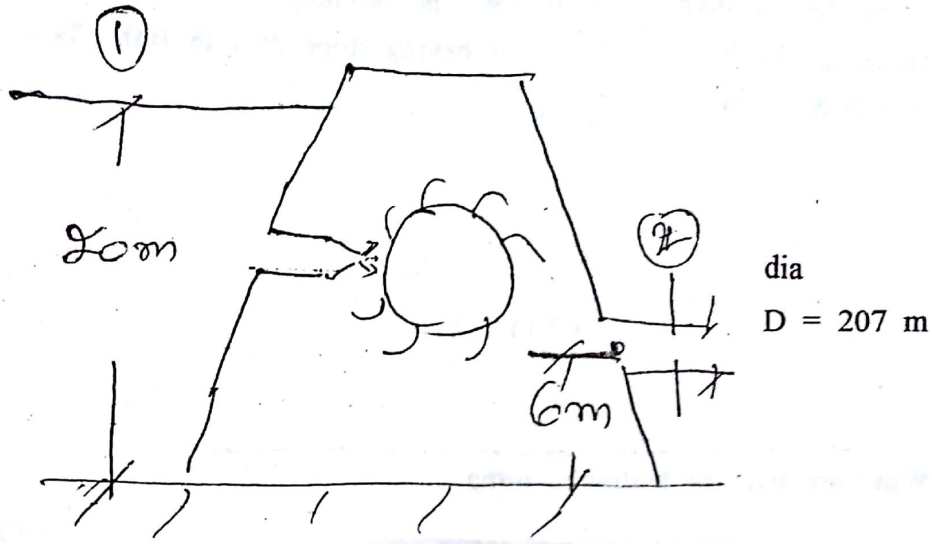

Fig. 2

16

OR

5 Give with neat sketches detailed classification of turbines.

16

RTU paper

04/7/2015

4E4113

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4E4113

B.Tech. IVSemester (Main/Back) Examination, June/July - 2015

Civil Engineering

4CE3A Hydraulics and Hydraulic Machines

Time : 3 Hours **Maximum Marks : 80**

Min. Passing Marks : 26

Instructions to Candidates:

*Attempt any **five** questions, selecting **one** question from **each unit**. All questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.*

Unit - I

1. a) Define the dimensional homogeneity with at least two suitable examples. **(8)**

b) A 7.2 m high and 15 m long spillway discharge 94m/s of water under a head of 2.0m. if a 1:9 scale model of this spillway is to be constructed, determine model dimension, head over the spillway model and model discharge. If model experience a force of 7500 N, determine force on the prototype. **(8)**

OR

1. a) Illustrate the difference between flow through pipes and flow through channels. **(4)**

b) A rectangular channel carries water at the rate of 400 liters/sec when bed slope is 1 in 2000. Find the most economical dimension of the channel if C=50 and justify your answer. **(4)**

c) Show that Reynolds number, $\rho ud/\mu$ is non-dimensional. If the discharge Q through an orifice is a function of the diameter d, the pressure difference p, the density ρ, and the viscosity μ, show that $Q=Cp^{1/2}d^2/\rho^{1/2}$ where C is some function of the non-dimensional group $(d\rho^{1/2}p^{1/2}/\mu)$. **(8)**

RTU paper

Unit - II

2. a) Explain why pressure gradient in the direction of flow is equal to the shear gradient in the direction normal to the direction of flow. Derive a generalized equation for all types of flow and boundary conditions for the above statement. **(10)**

b) A total of 12 liters/sec of oil is pumped through two pipes in parallel, one 12 cm in diameter and the other is 10 cm in diameter, both pipes are 1000m long. The specific gravity of the oil is 0.97 and the kinematic viscosity 9.0 cm^2/s. Calculate the flow rate through each pipe and the power of the pump. **(6)**

OR

2. a) Derive an expression for pressure drop down a pipe in terms of friction factor. **(4)**

b) In a pipe of diameter 100mm, carrying water, the velocities at the pipe center and 30 mm from the pipe center are found to be 2.5 m/s and 2.2 m/s respectively. Find the wall shearing stress. **(4)**

c) Consider a circular ring of radius, r and thickness dr, derive a common expression for velocity distribution for smooth and rough pipe. **(8)**

Unit - III

3. a) State and explain the Geometric properties of Rectangular, Triangular, Trapezoidal and Circular channels with suitable example **(8)**

b) A concrete lined trapezoidal channel with uniform flow has a normal depth is 2m. The base width is 5m and the side slopes are equal at 1:2 Manning's 'n' can be taken as 0.015 And the bed slope S_0=0.001. Calculate Discharge (Q), Mean velocity (V) and Reynolds number (Re). Given ρ = 1000 kg/m^3 and Viscosity 'μ' =1.14×10^{-3}N-s/m^2. **(8)**

OR

3. a) A triangular gutter whose sides include an angle of 60° conveys water at a uniform depth of 300 mm. If the bed gradient is 1 in 150 find the discharge. Take Chezy's constant C=55 $m^{1/2}/s$. **(8)**

b) A canal has a bottom width of 4m and sides with a slope of 1 vertical to 1.5 horizontal. The depth of water is 1.0m when the discharge is $4m^3/s$.

a) Calculate the slope of the channel bed using the Manning formula with n=0.022.

b) Calculate the discharge in m^3/s when the depth of flow is 1.2m. **(8)**

Unit - IV

4. a) Why hydraulic jump is used as an energy dissipater at the toe of the spillway of a dam? Discuss different way of obtaining hydraulic jump. **(8)**

b) A sluice gate discharges water into a rectangular channel with a velocity of 5.0 m/s and depth of flow is 0.4 m. The width of the channel is 6.0 m. Determine hydraulic jump will occur, if yes find its height and loss of energy per kg of water. Determine the power lost in the hydraulic jump. **(8)**

OR

4. a) Derive an expression for force exerted by a jet of water on a moving semi circular plate in the direction of the jet when the jet strikes at the centre of the semi circular plate. **(8)**

b) A jet of water with a velocity of 40 m/s strikes a curved vane which moves with a velocity of 20 m/s. The jet makes an angle of 30° in the direction of motion of vane at the inlet and leaves at 90° to the direction of motion of the vane at the outlet. Determine vane angle at the outlet, if water enters and leaves without shock a ıd also determine efficiency. **(8)**

Unit - V

5. a) Derive an expression for the minimum starting speed of a centrifugal pump. **(6)**

b) Define priming of a centrifugal pump and how it is done? **(4)**

c) A centrifugal pump runs at 1000 rpm and delivers water against a head of 15.0 m, The impeller diameter and width at the outlet are 0.3 and 0.05m respectively. The vanes are curved back at an angle of 30^0 with the periphery at the outlet. If the maximum efficiency is 92%, find the discharge. **(6)**

OR

5. a) Draw the neat sketch of a Kaplan turbine with its parts and explain its working. **(8)**

b) A Kaplan turbine runner is to be designed to develop 10MW. The net head is 0.6m, the speed ratio = 2.09, flow ratio = 0.68, overall efficiency is 80% and the diameter of the boss is 1/3 diameter of the runner. Find the diameter of the runner, speed and specific speed of the turbine. **(8)**