

HYDRAULICS AND HYDRAULIC MACHINERY

Subject code: **CE405PC**

Regulations: R18-JNTUH

Class: II Year B. Tech CE II Sem



DEPARTMENT OF CIVIL ENGINEERING
BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY
Ibrahimpattam - 501 510, Hyderabad

HYDRAULICS AND HYDRAULIC MACHINERY
(CE405PC)
COURSE PLANNER

I. COURSE OVERVIEW:

This course is intended to introduce basic principles of fluid mechanics. It is further extended to cover the application of fluid mechanics by the inclusion of fluid machinery especially water turbine and water pumps. Now days the principles of fluid mechanics find wide applications in many situations directly or indirectly. The use of fluid machinery, turbines pumps in general and in power stations in getting as accelerated fill up. Thus there is a great relevance for this course for mechanical technicians. The Mechanical technicians have to deal with large variety of fluids like water, air, steam, ammonia and even plastics. The major emphasis is given for the study of water. However the principle dealt with in this course will be applicable to all incompressible fluids

II. PREREQUISITE(S):

Level	Credits	Periods	Prerequisite
UG	4	5	Fluid Mechanics

III. COURSE OBJECTIVES:

1	Strengthen the knowledge of theoretical and technological aspects of hydrodynamic forces on jets.
2	Correlate the principles with applications in hydraulic turbines.
3	Apply the practical applications on Francis and Kaplan turbine.
4	Analysis the similarities between prototype and model types of hydraulic similitude.

IV. COURSE OUTCOMES:

Course Outcomes	Description	Bloom's Taxonomy Levels	Program Outcomes, Program Specific Outcomes
CO1	Apply their knowledge of fluid mechanics in addressing problems in open channels and hydraulic machinery.	L3: Applying	PO1,PO2,PO3,PSO2.

CO2	Understand and solve problems in uniform, gradually and rapidly varied flows in open channel in steady state conditions.	L2:Understand, L4: Analyzing	PO2,PO3,PO4,PO6, PSO1.
CO3	Apply dimensional analysis and to differentiate the model, prototype and similitude conditions for practical problems.	L3: Applying	PO1, PO3,PO4, PSO1.
CO4	Get the knowledge on different hydraulic machinery devices and its principles that will be utilized in hydropower development and for other practical usages	L1 : Remember, L2:Understand, L3: Applying	PO1,PO3,PO4,PO5,PSO3.

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (PO)		Level	Proficiency assessed by
PO1	Engineering knowledge: To Apply the knowledge of mathematics, science, engineering fundamentals/principals, and civil engineering to the solution of complex engineering problems encountered in modern engineering practice.	3	Assignments
PO2	Problem analysis: Ability to Identify, formulate, review research literature, and analyze complex engineering problems related to Civil Engineering and reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Exercise, Exams
PO3	Design/development of solutions: Design solutions for complex engineering problems related to Civil Engineering and design system components or processes that meet the specified	2	Exercise

	needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.		
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2.7	Discussion, Seminars
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	Discussion, Seminars
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Civil Engineering professional engineering practice.	2	Discussions
PO7	Environment and sustainability: Understand the impact of the Civil Engineering professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	–	-----
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	–	-----
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	–	-----
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear	–	-----

	instructions.		
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	–	-----
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage independent and life-long learning in the broadest context of technological change.	–	Prototype, Discussions

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) 0 : None

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program specific outcomes		Level	Proficiency Assessed By
PSO 1	ENGINEERING KNOWLEDGE: Graduates will be able to apply technical knowledge in drawing, analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good basics in mathematics, basic sciences and technical communication	2.5	Lectures, Exercises and Assignments
PSO 2	BROADNESS AND DIVERSITY: Graduates will be able to summarize and can demonstrate about societal, economical, environmental, health and safety factors involved in infrastructural development, and shall work within multidisciplinary teams with competence in modern	2	Project
PSO 3	SELF-LEARNING AND SERVICE: Graduates will be able to pursue lifelong learning and professional development to face the challenging and emerging needs of society and the environment	2	Guest lectures

0-None 2-Supportive 3-Highly Related

VII. SYLLABUS: JNTUH SYLLABUS

UNIT - I

Open Channel Flow – I: Introduction to Open channel flow-Comparison between open channel flow and pipe flow, Classification of open channels, Classification of open channel flows, Velocity distribution. Uniform flow – Characteristics of uniform flow, Chezy's, Manning's and Bazin formulae for uniform flow – Factors affecting Manning's

Roughness Coefficient “n”. Most economical sections. Computation of Uniform flow, Normal depth.

Critical Flow: Specific energy – critical depth - computation of critical depth – critical, sub critical and super critical flows-Channel transitions.

UNIT - II

Open Channel Flow – II: Non-uniform flow – Gradually Varied Flow - Dynamic equation for G.V.F; Classification of channel bottom slopes – Classification and characteristics of Surface profiles – Computation of water surface profiles by Numerical and Analytical approaches. Direct step method.

Rapidly varied flow: Elements and characteristics (Length and Height) of Hydraulic jump in rectangular channel– Types, applications and location of hydraulic jump, Energy dissipation and other uses – Positive and Negative Surges (Theory only).

UNIT - III

Dimensional Analysis and Hydraulic Similitude: Dimensional homogeneity – Rayleigh’s method and Buckingham’s pi methods – Dimensionless groups. Similitude, Model studies, Types of models. Application of dimensional analysis and model studies to fluid flow problems. Distorted models.

Basics of Turbo Machinery: Hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes, Jet striking centrally and at tip, Velocity triangles at inlet and outlet, expressions for work done and efficiency –Angular

UNIT - IV

Hydraulic Turbines – I: Elements of a typical Hydropower installation – Heads and efficiencies – Classification of turbines – Pelton wheel – Francis turbine – Kaplan turbine – working, working proportions, velocity diagram, work done and efficiency, hydraulic design. Draft tube – Classification, functions and efficiency.

Hydraulic Turbines – II: Governing of turbines – Surge tanks – Unit and specific turbines – Unit speed – Unit quantity – Unit power – Specific speed – Performance characteristics – Geometric similarity – Cavitation. Selection of turbines.

UNIT - V

Centrifugal Pumps: Pump installation details – classification – work done – Manometric head – minimum starting speed – losses and efficiencies – specific speed. Multistage pumps – pumps in parallel – performance of pumps – characteristic curves – NPSH – Cavitation.

Hydropower Engineering: Classification of Hydropower plants – Definition of terms – load factor, utilization factor, capacity factor, estimation of hydropower potential.

TEXT BOOKS:

1. Fluid Mechanics by Modi and Seth, Standard Book House.
2. Fluid Mechanics and Hydraulic machines by Manish Kumar Goyal, PHI Learning Private Limited, 2015
3. Fluid mechanics & Hydraulic Machines, Domkundwar & Domkundwar Dhanpat Rai & Co

REFERENCE BOOKS:

1. Fluid Mechanics by R. C. Hibbeler, Pearson India Education Services Pvt. Ltd
2. Fluid Mechanics & Fluid Power Engineering by D. S. Kumar (Kataria & Sons Publications Pvt. Ltd.).
3. Open channel flow by V.T. Chow (McGraw Hill Book Company).
4. Introduction to Fluid Mechanics and Fluid Machines by SK Som, Gautam Biswas, Suman Chakraborty, McGraw Hill Education (India) Private Limited
5. Hydraulic Machines by Banga & Sharma (Khanna Publishers).

MOOC'S- SWAYAM/ NPTEL:

<https://nptel.ac.in/courses/151516/#>

<https://nptel.ac.in/courses/151516>

GATE SYLLABUS:

Laminar and turbulent flow flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling. Kinematics of flow, velocity triangles and specific speed of pumps and turbines.

IES SYLLABUS:

A. open channel flow, pipe flow

Dimensional Analysis, Modeling; Cavitations; Flow oscillations; Momentum and Energy principles in Open channel flow, Flow controls, Hydraulic jump, Flow sections and properties; Normal flow, Gradually varied flow; Surges; Flow development and losses in pipe flows, Measurements; Siphons; Surges and Water hammer; Delivery of Power Pipe networks.

B. Hydraulic machines and hydropower

Centrifugal pumps, types, performance parameters, scaling, pumps in parallel; Reciprocating pumps, air vessels, performance parameters; Hydraulic ram; Hydraulic turbines, types, performance parameters, controls, choice; Power house, classification and layout, storage, pondage, control of supply.

VIII. COURSE PLAN:

Lecture No.	Week	Unit	Topics to be covered	Learning Objective	Teaching Methodology	References
1.	1	1	Introduction to Open channel flow- Comparison between open channel flow and pipe flow	To know the types of flows	Chalk and Talk	T1,T2
2.	1	1	Classification of open channels, open channel flows	To know the Type of channels	Chalk and Talk	T1,T2
3.	1	1	Velocity Distribution	To know Velocity distribution	Chalk and Talk	T1,T2
4.	1	1	Uniform flow – Characteristics of uniform flow	To know the Characteristics of uniform flow	Chalk and Talk	T1,T2
5.	1	1	Chezy's, Manning's and Bazin Formulae	Ability to solve the problems on Chezy's, Manning's and Bazin formulae for uniform flow.	Chalk and Talk	T1,T2
6.	2	1				

			for Uniform Flow			
7.	2	1	Factors affecting Manning's Roughness Coefficient "n"	To know the factors affecting "n".	Chalk and Talk	T1,T2
8.	2	1	Most economic Sections	Ability to know the Most Economical sections	Chalk and Talk	T1,T2
9.	2	1				
10.	2	1	Computation of Uniform flow, Normal depth.	Ability to compute normal depth	Chalk and Talk	T1,T2
11.	3	1				
12.	3	1	Specific energy – critical depth - computation of critical depth	To understand the Basics of Critical Flow.	Chalk and Talk	T1,T2
13.	3	1			Chalk and Talk	T1,T2
14.	3	1	critical, sub critical and super critical flows	Ability to understand flows	Chalk and Talk	T1,T2

15.	3	2	Channel transitions, Non-uniform flow – Gradually Varied Flow	To understand the transitions in channels.	Chalk and Talk	T1,T2
16.	4	2	Non uniform flow- Dynamic equation for G.V.F., Mild, Critical, Steep, horizontal and adverse slopes	Ability to understand Non uniform flow- Dynamic equation for G.V.F., Mild, Critical, Steep	Chalk and Talk	T1,T2
17.	4	2				
18.	4	2	Classification of channel bottom slopes, characteristics of Surface profiles Computation of water surface profiles by Numerical and Analytical approaches-	To study of channel slopes and surface profiles To compute the water surface profile	Chalk and Talk	T1,T2

			Direct step method.			
19.	4	2	Computation of water surface profiles by Numerical and Analytical approaches- Direct step method.	To compute the water surface profile	Chalk and Talk	T1,T2
20.	4	2				
21.	5	2	Elements and characteristics (Length and Height) of Hydraulic jump in rectangular channel	To know about hydraulic jump	Chalk and Talk	T1,T2
22.	5	2	Types, applications and location of hydraulic jump	To know about hydraulic jump	Chalk and Talk	T1,T2
23.	5	2	Energy dissipation, Positive and Negative Surges	To know about the uses of hydraulic jump	Chalk and Talk	T1,T2
24.	5	3	Dimensional analysis	To understand the Dimensional analysis,	Chalk and Talk	T1,T2
25.	5	3	Rayleigh's	Ability to solve	Chalk and	T1,T2

26.	6	3	method	the problems Rayleigh's method	Talk	
27.	6	3	Buckingham's pi theorem	Ability to solve the problems Buckingham's pi theorem	Chalk and Talk	T1,T2
28.	6	3				
29.	6	3	Hydraulic similitude	To know the hydraulic similitude	Chalk and Talk	T1,T2
30.	6	3	Study of Hydraulic models	To study of Hydraulic models	Chalk and Talk	T1,T2
31.	7	3	Geometric, kinematic and dynamic similarities	Ability to solve the problems on Geometric, kinematic and dynamic similarities	Chalk and Talk	T1,T2
32.	7	3	Dimensionless numbers	Ability to solve dimensionless numbers	Chalk and Talk	T1,T2
33.	7	3	Model and prototype relations.	Ability to solve model and prototype relations	Chalk and Talk	T1,T2
34.	7	3	Hydrodynamic force of jets on stationary and moving flat, in lined and curved vanes,	To know the Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes.	Chalk and Talk	T1,T2
35.	7	3				

36.	8	3	Problems solving on Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes.	Ability to solve the problems on Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes	Chalk and Talk	T1,T2
37.	8	3				
38.	8	3	jet striking centrally and at tip, velocity triangles at inlet and outlet	To know the jet striking centrally and at tip, velocity triangles at inlet and outlet.	Chalk and Talk	T1,T2
39.	8	3	Problems solving on jet striking centrally and at tip, velocity triangles at inlet and outlet	Ability to solve the problems jet striking centrally and at tip, velocity triangles at inlet and outlet	Chalk and Talk	T1,T2
40.	8	3				
41.	9	3	expressions for work done and efficiency	Ability to calculate work done and efficiencies	Chalk and Talk	T1,T2
42.	9	3	Angular momentum principle	Ability to calculate angular momentum	Chalk and Talk	T1,T2

43.	8	3	Applications to radial flow turbines	To know radial flow applications	Chalk and Talk	T1,T2
44.	9	3				
45.	9	4	Layout of typical hydropower installation	Able to make layout of hydropower	Chalk and Talk	T1,T2
46.	10	4				
47.	10	4	Heads and Efficiencies	Able to calculate heads and efficiencies of pumps	Chalk and Talk	T1,T2
48.	10	4				
49.	10	4	Classification of turbines	To know classification of turbines	Chalk and Talk	T1,T2
50.	10	4	Pelton wheel - Francis turbine-, hydraulic design, draft tube	To know classification of turbines- pelton wheel, Francis turbine	Chalk and Talk	T1,T2
51.	11	4				
52.	11	4	Kaplan turbine-working, working proportions,	To know classification of Kaplan turbine working, working Proportions.	Chalk and Talk	T1,T2
53.	11	4	velocity diagram, work done	To know velocity diagram, hydraulic design, draft tube,	Chalk and Talk	T1,T2
54.	11	4				

			and efficiency			
55.	11	4	Theory and function efficiency	To know theory and function efficiency.	Chalk and Talk	T1,T2
56.	12	4	Governing of turbines	Ability to know Governing of turbines	Chalk and Talk	T1,T2
57.	12	4				
58.	12	4	Unit and specific turbines-unit speed	Ability to know Governing of unit and specific turbines, unit speed	Chalk and Talk	T1,T2
59.	12	4				
60.	12	4	Performance characteristics-geometric similarity	Ability to know performance characteristics, geometric similarity	Chalk and Talk	T1,T2
61.	13	4				
62.	13	4	Cavitations	Ability to know cavitations	Chalk and Talk	T1,T2
63.	13	5	Pump installation details-classification - work done	To study the Pump installation details, classification, Work done	Chalk and Talk PPT	T1,T2
64.	13	5				
65.	13	5	Manometric head-minimum starting speed-losses and efficiencies	To study Manometric head, minimum starting speed losses and efficiencies	Chalk and Talk PPT	T1,T2

66.	14	5	specific speed multistage pumps- pumps in parallel	Ability to solve problems on specific speed , multi stage pumps , pumps in pumps in parallel	Chalk and Talk	T1,T2
67.	14	5	performanc e of pumps- characteristi c curves	Ability to solve the problems on performance of pumps , characteristic curves	Chalk and Talk	T1,T2
68.	14	5	NPSH - cavitations	Ability to solve the problems on NSPH cavitation	Chalk and Talk	T1,T2
69.	14	5				
70.	14	5	Hydropowe r Engineering : Classificati on of Hydropowe r plant	Ability to solve the problems on hydro power plants	Chalk and Talk	T1,T2
71.	15	5				
72.	15	5	Definition of terms – load factor, utilization factor, capacity factor	Definition of terms : load factor , utilization factor , capacity factor	Chalk and Talk	T1,T2
73.	15	5				
74.	15	5	estimation of hydropower potential	definition of terms : estimation of hydro power potential.	Chalk and Talk	T1,T2
75.	15	5				

76.	16		Revision			
77.	16		Revision			
78.	16		Revision			
79.	16		Revision			
80.	16		Revision			

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
I	3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
II	-	3	2	3	-	2	-	-	-	-	-	-	3	-	-
III	3	-	2	2	-	-	-	-	-	-	-	-	2	-	-
IV	3	-	2	3	3	-	-	-	-	-	-	-	-	-	2
AVG	2.25	1.5	2	2	0.75	0.5	-	-	-	-	-	-	1.25	0.5	0.5

**X. QUESTION BANK: (JNTUH)
DESCRIPTIVE QUESTIONS**

UNIT-I

SHORT ANSWER QUESTIONS-

S. NO	Question	Blooms Taxonomy Level	Programme Out come
1.	Explain about the flow in open channel with a neat sketch.	Understand	1
2.	Differentiate between critical, sub critical and super critical flow in open Channel.	Understand	2

3.	What do you mean by economical section of a channel? Explain the conditions applied.	Understand	2
4.	Explain the terms specific energy of a flowing liquid in an open channels	Remember	2
5.	Explain the term mild slope, critical slopes, steep slopes, horizontal slopes and adverse slopes.	Remember	5
6.	Explain specific energy curve.	Remember	2
7.	Explain the characteristics of uniform flow	Understand	2
8.	Explain the difference between open channel flow and pipe flow	Understand	2
9.	Write chezy's, manning's and bazin's formula for calculating discharge through open channels	Remember	2
10.	Classify open channels	Remember	3

LONG ANSWER QUESTIONS

S. No	Question	Blooms Taxonomy Level	Programme Out come
1.	Derive an expression for the discharge through a channel by chezy's formula.	Understand	3
2.	Derive the conditions for most economical section of a rectangular channel	Understand	2
3.	Derive the conditions for the best side slope of the most economical trapezoidal section.	Remember	2
4.	Prove that for a channel of circular section, the depth of flow, $d=0.81D$, D for maximum velocity, and $d=0.95D$ for maximum discharge, D =diameter of a circular channel, d = depth of flow.	Understand	3
5.	Derive an expression for critical depth and critical velocity.	Remember	2

6.	Derive the condition for maximum discharge for a given value of specific energy.	Remember	2
7.	Explain different channel transitions	Understand	2
8.	Prove that for trapezoidal channel sections, hydraulic mean depth= $\frac{1}{2}$ (depth of flow)	Understand	2
9.	What is the relation between manning's and chezy's constants	Remember	2
10.	Prove that for circular channel section, $d=0.81D$ for maximum velocity.	Remember	3

UNIT-2

SHORT ANSWER QUESTIONS-

S · N O	Question	Blooms Taxonomy Level	Programme Out come
1.	Explain different types of channels based on depth of flow.	Remember	1
2.	Define back water curve and explain how does it forms in a channel.	Remember	2
3.	Explain the differences between channel and rivers.	Remember	5
4.	Explain the velocity distribution diagram of an open channel and write the condition for maximum velocity.	Remember	5
5.	Explain with a neat sketch the velocity distributions of rectangular, trapezoidal open channels.	Remember	5
6.	Write the applications of hydraulic jump	Remember	2
7.	Write the classification of channel bottom slopes.	Understand	2
8.	What is energy dissipation	Understand	2
9.	Define hydraulic jump	Remember	2
10.	Find an expression for loss of energy head for a	Understand	2

	hydraulic jump		
--	----------------	--	--

LONG ANSWER QUESTIONS-

S. NO	Question	Blooms Taxonomy Level	Programme Out come
1.	Derive an expression for the depth of hydraulic jump in terms of upstream Froude number.	Understand	2
2.	Derive the differential equation for steady gradually varied flow open Channels and list all assumptions?	Understand	2
3.	Prove that the loss of energy head in a hydraulic jump is equal to where d_1 and d_2 are the conjugate depths.	Remember	2
4.	Find the discharge through a rectangular channel of width 2mts, having a bed slope of 4 in 8. The depth of flow is 1.5mts and take the value of N in Manning's formula as .12.	Remember	3
5.	Derive the dynamic equation for Gradually Varied flow.	Understand	2
6.	Write the classification and characteristics of surface profiles	Remember	2
7.	Write the application and location of hydraulic jump	Understand	2
8.	Elements and characteristics of hydraulic jump in rectangular channel	Remember	5
9.	What is difference between gradually varied flow and rapidly varied flow	Remember	5
10.	How to compute the water surface profile using Direct step method?	Remember	5

UNIT-3

SHORT ANSWER QUESTIONS-

S. N O	Question	Blooms Taxonomy Level	Programme Out come
1.	a. Define the term dimensional analysis and model analysis. b. Discuss the difference between model and prototype with examples of each.	Remember	6
2.	a. Discuss fundamental and derived units. Give examples. b. Explain the term “dimensionally homogeneous equation”.	Understand	6
3.	a. Enumerate the method of analysis for dimensional quantities. b. State Rayleigh’s theorem	Understand	6
4.	a. Explain the term of Geometric similarity with formula. b. Explain the term of Kinematic similarity with formula. c. Explain the term of Dynamic similarity with formula.	Understand	7
5.	Define the term impact of jets with neat sketch? Obtain an expression for the force exerted by a jet of water on a fixed vertical plate in the direction of jet.	Understand	12
6.	Water is flowing through a pipe at the end of which a nozzle is fitted .the diameter of the nozzle 100mm and the head of water at the centre of nozzle is 100 m .find the force exerted by the jet of water on a fixed vertical plate the coefficient of velocity is given as 0.95.	Remember	12

7.	A jet of water of diameter 50mm moving with a velocity of 40 m/s, strikes a curved fixed symmetrical plate at the centre. Find the force exerted by the jet of water in the direction the jet, if the jet is deflected through an angle of 120° at the outlet of the plate..	Remember	12
8.	Obtain an expression for the force exerted by a jet of water on a flat vertical plate moving in the direction of jet	Understand	12
9.	a. Write the equation for the force exerted by a jet of water on a moving inclined plate. b. Write the equation for the force exerted by a jet of water on a fixed curved plate at centre. c. Write the equation for the force exerted by a jet of water on a fixed curved plate at one end tangentially when the plate is symmetrical.	Understand	13
10.	a. Write the equation for the force exerted by a jet of water on a fixed curved plate at one end tangentially when the plate is unsymmetrical. b. Write the equation for the force exerted by a jet of water on a moving curved plate at center.	Understand	13

LONG ANSWER QUESTIONS-

S. NO	Question	Blooms Taxonomy Level	Programme Out come
1.	a. Describe the Rayleigh's method for dimensional analysis.	Remember	8

	b.Explain the different types of hydraulic similarities that must exist between a proto type and its model?		
2.	a.Explain the different laws on which models are designed for dynamic similarity? Where are they used? b.Prove that ratio of inertia force to viscous force gives the Reynold"s number?	Understand	8
3.	a.Explain about the scale ratios for distorted models. b.Determine the dimensions of the quantities given below : i. angular velocity ii. angular acceleration iii. discharge iv. kinematic viscosity v. force vi. Specific weight.	Understand	8
4.	a.The time period of a pendulum depends upon the length of the pendulum, Acceleration due to gravity. Determine expression for time period using Rayleigh"s method. b.Find an expression for the drag force on smooth sphere of diameter "D" with Uniform velocity "V" in a fluid of density and dynamic viscosity	Remember	7
5.	a.Explain the force on the inclined plate moving in the direction of the jet ? b.Explain the force on the curved plate when the plate is moving in the direction of jet.	Remember	12

6.	<p>a.Explain the force exerted by a jet of water on an unsymmetrical moving curved plate when jet strikes tangentially at one of the tips ?</p> <p>b.Explain the force exerted on a series of radial curved vanes?</p>	Understand	12
7.	<p>In a jet propelled boat water is drawn a mid ship and discharged at the back with an absolute velocity of 20 m/s. If the cross - sectional area of the jet is 200 cm² and the boat is moving in sea water with a speed of 8.33 m/s determine:</p> <p>i. The propelling force on the boat. ii. Power required to drive the pump and iii. Efficiency of jet propulsion</p>	Understand	13
8.	<p>a.Write the components of hydro power plants and explain them in detail.</p> <p>b.What are the steps involved in calculating the hydro power with the units?</p> <p>c.Define head and explain different types of head.</p>	Remember	13
9.	<p>Explain in detail different types of efficiencies and write them with formula of each.</p>	Remember	13
10.	<p>The following data relate to a proposed hydro – electric station: Available head = 28 m, catchment area = 420 Sq. Km. Rainfall = 140 cm /year, percentage of total rainfall utilized = 68 %, Penstock efficiency = 94 %, Turbine efficiency = 80 %, generator efficiency = 84 % and load factor = 44 %. Determine the following a. The power developed by turbine. b. Suggest suitable machines corresponding to the given data and specify the same.</p>	Understand	13

UNIT-4

SHORT ANSWER QUESTIONS-

S. NO	Question	Blooms Taxonomy Level	Program me Out come
1.	Define turbine and different types of turbine with neat sketch?	Remember	16
2.	Discuss about following efficiencies: i) hydraulic efficiency ii) mechanical efficiency iii) volumetric efficiency iv) overall efficiency.	Understand	17
3.	Write short notes on classification of hydraulic turbines.	Understand	16
4.	Discuss about various parts of pelton wheel.	Remember	17
5.	Discuss about various parts of radial flow reaction turbines.	Understand	16
6.	What are governing of turbines?	Remember	17
7.	Define surge tanks With neat sketch .	Remember	16
8.	Define the following: i) unit speed ii) unit power iii)unit discharge.	Understand	16
9.	Discuss about specific speed performance of turbine.	Remember	16
10.	Explain about cavitation in turbines.	remember	16

LONG ANSWER QUESTIONS-

S. NO	Question	Blooms Taxonomy Level	Programme Out come
1.	Define a draft tube? What are its functions?	Understandi ng	16
2.	Differentiate between an inward and out ward flow reaction turbine?	Remember	17

3.	Define cavitation? How can it be avoided in reaction turbine ?	Remember	16
4.	Understanding by characteristic curves of a turbine? Name the important types of characteristic curves?	Remember	16
5.	Define the term governing of turbines? Describe with a neat sketch the working of an oil pressure governor?	Remember	17
6.	A pelton turbine develops 3000 Kw under a head of 300 m. The overall efficiency of the turbine is 83 % . If speed ratio = 0.46 , $cv=0.98$ and specific speed is 16.5 , then find : i) diameter of the turbine and ii) diameter of the jet.	Remember	16
7.	A turbine develops 9000 kW when running at a speed of 140 r. p m and under a head of 30 m .Determine the specific speed of the turbine.	Understand	16
8.	Derive an expression for specific speed of a turbine.	Remember	17
9.	A water turbine has a velocity of 6 m/s at the entrance to the draft tube and a velocity of 1.2 m/s at the exit. For friction losses of 0.1 m and a tailwater 5m below the entrance to the draft tube, find the pressure head at the entrance.	Remember	16
10.	A turbine is to operate under a head of 25 m at 200 r. p .m. The discharge is 9 cumsec. i. Specific speed of turbine ii. Power generated iii. Type of machine	Understand	16

UNIT-5

SHORT ANSWER QUESTIONS-

S.	Question	Blooms Taxonomy	Programme
----	----------	-----------------	-----------

NO		Level	Out come
1.	Define pump and discuss about pump installation?	Remember	20
2.	Discuss about classification of pumps?	Understand	19
3.	Define the following :i) suction head ii) delivery head iii)static head	Remember	18
4.	Explain minimum speed for starting a centrifugal pump?	Remember	20
5.	Define multi stage centrifugal pump?	Understand	20
6.	Discuss about performance of pumps?	Remember	20
7.	Discuss about the classification of hydro power plants.	Remember	19
8.	Define the following : i) Load factor ii) Utilization factor iii) Capacity factor	Remember	20
9.	What do You understand by the term Net Positive Suction Head (NPSH)	Understand	20
10.	Enumerate the losses which occur when a centrifugal pump operates.	Understand	18

LONG ANSWER QUESTIONS-

S. NO	Question	Blooms Taxonomy Level	Program me Out come
1.	Define a centrifugal pump. Explain the working of a single –stage centrifugal pump with sketches.	Remember	20
2.	Differentiate between the volute casing and vortex casing for the centrifugal pump. Obtain an expression for the work done by the impeller of a centrifugal pump on water per second per unit weight of water.	Remember	21
3.	Define the terms i) suction head ii) delivery head	Remember	19

	iii) static head iv) manometric head		
4.	A centrifugal pump is to discharge 0.118 m ³ /s at a speed of 1450 r.p.m against a head of 25 m. The impeller diameter is 250 mm, its width at outlet is 50 mm and manometric efficiency is 75 %. Determine the vane angle at the outer periphery of the impeller.	Understand	20
5.	A centrifugal pump running at 800 r.p.m is working against a total head of 20.2 m. The external diameter of the impeller is 480 mm and outlet width is 60 mm. If the vanes angle at outlet is 40° and manometric efficiency is 70 %. Determine: a. Flow velocity at outlet. b. Absolute velocity of water leaving the vane. c. Angle made by the absolute velocity at outlet with the direction of motion at outlet, and d. Rate of flow through pump.	Understand	20
6.	It is required to deliver 0.048 m ³ /s of water to a height of 24 m through a 150 mm diameter and 120 m long, by a centrifugal pump. If the overall efficiency of the pump is 75 % and co-efficient of friction, $f = 0.01$ for pipe line, find the power required to drive the pump.	Understand	20
7.	A centrifugal impeller has dimensions and blade angles as given below. Water at the rate of 60 liters per second enters the impeller radially and the radial velocity remains constant in the impeller. Determine the impeller speed and torque produced by it. Use the following data: $R_1 = 7.5$ cm, $R_2 = 15$ cm, $\beta_1 = \beta_2 = 30^\circ$. Impeller inlet area – $A_1 = 250$ cm ² .	Remember	20
8.	A three stage centrifugal pump has impeller 400 mm in diameter and 20 mm wide. The vane angle at outlet is 45° and the area occupied by the thickness of the vanes may be assumed 8 % of the	Understand	21

	total area. If the pump delivers 3.6 m ³ of water per minute when running at 920 r p m. Determine: a. Power of the pump. b. Manometric head c. Specific speed Assume mechanical efficiency = 88 % and Manometric efficiency = 77 %.		
9.	Find the power required to drive a centrifugal pump which delivers 0.04 m ³ /s of water to a height of 20 m through a 15 cm diameter pipe and 100 m long. The overall efficiency of the pump is 70% and coefficient of friction $f = 0.15$ in the formula	Understand	22
10.	The internal and external diameters of the impellers of a centrifugal pump are 300 mm and 600 mm respectively. The pump is running at 1000 r. p.m. The vane angles at inlet and outlet are 200 and 300 respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water.	Understand	20

XI. OBJECTIVE QUESTIONS: JNTUH

UNIT 1

- For subcritical flow in an open channel, the control section for gradually varied flow profiles is
(A) at the downstream end (B) at the upstream end
(C) at both upstream and downstream ends (D) at any intermediate section
- The normal depth in a wide rectangular channel is increased by 10%. The percentage increase in the discharge in the channel is:
(A) 20.1 (B) 15.4 (C) 10.5 (D) 17.2
- A trapezoidal channel is 10.0 m wide at the base and has a side slope of 4 horizontal to 3 vertical. The bed slope is 0.002. The channel is lined with smooth concrete (Manning's $n = 0.012$). The hydraulic radius (in m) for a depth of flow of 3.0 m is
(A) 20.0 (B) 3.5 (C) 3.0 (D) 2.1
- A rectangular open channel of width 5.0 m is carrying a discharge of 100 m³/s. The Froude number of the flow is 0.8. The depth of flow (in m) in the channel is

(A) 4 (B) 5 (C) 16 (D) 20

5. The top width and the depth of flow in a triangular channel were measured as 4 m and 1 m, respectively. The measured velocities on the centre line at the water surface, 0.2 m and 0.8 m below the surface are 0.7 m/s, 0.6 m/s and 0.4 m/s, respectively. Using two-point method of velocity measurement, the discharge (in m³/s) in the channel is

(A) 1.4 (B) 1.2 (C) 1.0 (D) 0.8

6. For a given discharge, the critical flow depth in an open channel depends on

(A) Channel geometry only (B) Channel geometry and bed slope

(C) Channel geometry, bed slope and roughness (D) Channel geometry, bed slope, roughness and Reynolds number

7. Flow in open channels is defined as the flow of a liquid with a _____ surface.

8. If the depth of flow, velocity of flow, slope of the bed of channel and cross-section remain constant, the is called _____, otherwise it is called _____ flow.

9. For sub-critical flow, the Froude number is _____ and for super-critical flow, the Froude number is _____.

10. Velocity of Chezy's formula is given by _____.

UNIT 2

1. When the flow in an open channel is gradually varied, the flow is said to be

(A) steady uniform flow (B) steady non-uniform flow

(C) unsteady uniform flow (D) unsteady non-uniform flow

2. A thick liquid like a syrup has a _____ viscosity than a light liquid like water.

3. Which of the following assumptions about a GVF is false?

a) Channel is prismatic b) Pressure distribution is hydrostatic c) Flow characteristics change with time d) Roughness coefficient is constant

4. Determine the dynamic equation for the rate of change of depth having bed slope S_0 and slope of total energy line S_f .

a) $\frac{dy}{dx} = \frac{S_0 - S_f}{1 - \frac{Q^2 T}{g A^2}}$

b) $\frac{dy}{dx} = \frac{S_0 - S_f}{1 - \frac{Q^2 T}{g A^3}}$

c) $\frac{dy}{dx} = \frac{S_0 - S_f}{1 - \frac{Q^2 T}{g A^2}}$

d) $\frac{dy}{dx} = \frac{S_0 - S_f}{1 - \frac{Q^2 T}{g A}}$

5. The water surface profile for the flow d/s of a sluice gate in a channel with mild slope is
a. M1 b. M2 c. M3 d. None of the above.
6. At the control section, the depth is known
a. True b. False
7. Subcritical flow always occurs when the
a. Depth of flow is less than the critical depth b. Slope is mild c. Depth is more than the critical depth d. None of the above.
8. The standard step method aims to solve
a. The continuity equation b. The energy equation c. The momentum equation d. None of the above
9. When the depth of water increases in the direction of flow then the surface profile is classified as back water curve and when it decreases then it is called as draw down curve.
a. True b. False
10. In a sustaining slope the bottom slope is always
a) Zero b) Negative c) Positive d) Goes from positive to negative

UNIT 3

1. Efficiency of a series of vanes is given as _____ and condition of maximum efficiency is _____
2. For a curved radial vane, the work done per second is _____
3. For a curved radial vane the efficiency is given by _____
4. for a series of vanes, the force and workdone are given as _____ and _____
5. The liquid comes out in the form of a jet from the outlet of a nozzle, which is fitted to a pipe through which the liquid is flowing will be under _____
6. Group-I contains dimensionless parameters and Group- II contains the ratios.
- Group-I Group -II

- | | |
|--------------------|--|
| P. Mach Number | 1. Ratio of inertial force and gravitational force |
| Q. Reynolds Number | 2. Ratio of fluid velocity and velocity of sound |
| R. Weber Number | 3. Ratio of inertial force and viscous force |
| S. Froude Number | 4. Ratio of inertial force and surface tension force |

7. The correct match of dimensionless parameters in Group- I with ratios in Group-II is:
 (A) P-3, Q-2, R-4, S-1 (B) P-3, Q-4, R-2, S-1
 (C) P-2, Q-3, R-4, S-1 (D) P-1, Q-3, R-2, S-4
8. The ratio of inertia force to gravitational force acting in any flow, ignoring other forces, is called (A) Euler number (B) Froude number (C) Reynold number (D) Weber number
9. Flow in pipes is laminar if Reynolds number is_____.
10. The ratio of inertia force to elastic force acting in any flow, ignoring other forces, is called_____

UNIT 4

1. Cavitation is caused by
 A) High velocity B) low barometric pressure C) Low pressure D) high pressure
2. Unit power of a turbine is given by
 A) $P/H^{1/2}$ B) $P/H^{3/2}$ C) $P/H^{3/4}$ D) $P/H^{5/2}$
3. Francis turbine is
 A) an impulse turbine B) a reaction turbine C) a tangential flow turbine D) An impulse turbine
4. the hydraulic machines, which convert the hydraulic energy into mechanical energy, are called _____
5. Gross head is the vertical difference between the _____ race and _____ race.
6. Net head is also called as _____ head.
7. Hydraulic efficiency of turbine is given as _____ and mechanical efficiency is given as _____
8. Pelton wheel is a _____ flow impluse turbine and _____ head tubine.
9. Francis turbine is an _____ flow _____ turbine.
10. Draft tube is a pipe of gradually increasinfg area used for discharging water from exit of a _____ turbine.

UNIT 5

1. If hydro plant operate under a head of 100m,it may be classified as
 A) a very high speed plant B) high head plant
 C) Medium head plant D) low head plant

2. One of the river plant are usually
 - A) a very high speed plant
 - B) high head plant
 - C) Medium head plant
 - D) low head plan
3. A Double acting pump the theory of discharge is given by \
 - A) $Q=(2A-A_P)LN/60$
 - B) $(2A-A_P)LN/120$
 - C) $(2A-A_P)LN/90$
 - D) $(2A-A_P)LN/90$
4. A theoretical pump is
 - A) $ALN/60$
 - B) $ALN/30$
 - C) $ALN/120$
 - D) $ALN/180$
5. The hydraulic machine which converts the mechanical energy into _____ energy by means of centrifugal force is called _____ pump.
6. The centrifugal pump cts as a reverse of an inward radial flow _____ turbine.
7. The vertical height of the centre-line of the centrifugal pump from the water surface in the pump is called the _____ head.
8. _____ head is the vertical distance between the centre line of the pump and the water surface in the tank to which the water is lifted.
9. The Manometric efficiency of the pump is given as _____ and mechanical efficiency is given as _____.
10. The minimum speed for starting a centrifugal pump is given by _____.

XII. GATE QUESTIONS:

1. For subcritical flow in an open channel, the control section for gradually varied flow profiles is
 - (A) at the downstream end
 - (B) at the upstream end
 - (C) at both upstream and downstream ends
 - (D) at any intermediate section
2. The normal depth in a wide rectangular channel is increased by 10%. The percentage increase in the discharge in the channel is:
 - (A) 20.1
 - (B) 15.4
 - (C) 10.5
 - (D) 17.2
3. A trapezoidal channel is 10.0 m wide at the base and has a side slope of 4 horizontal to 3 vertical. The bed slope is 0.002. The channel is lined with smooth concrete (Manning's $n = 0.012$). The hydraulic radius (in m) for a depth of flow of 3.0 m is
 - (A) 20.0
 - (B) 3.5
 - (C) 3.0
 - (D) 2.1
4. A rectangular open channel of width 5.0 m is carrying a discharge of $100 \text{ m}^3/\text{s}$. The Froude number of the flow is 0.8. The depth of flow (in m) in the channel is

(A) 4 (B) 5 (C) 16 (D) 20

5. The top width and the depth of flow in a triangular channel were measured as 4 m and 1 m, respectively. The measured velocities on the centre line at the water surface, 0.2 m and 0.8 m below the surface are 0.7 m/s, 0.6 m/s and 0.4 m/s, respectively. Using two-point method of velocity measurement, the discharge (in m³/s) in the channel is
(A) 1.4 (B) 1.2 (C) 1.0 (D) 0.8
6. For a given discharge, the critical flow depth in an open channel depends on
(A) Channel geometry only (B) Channel geometry and bed slope
(C) Channel geometry, bed slope and roughness

(D) Channel geometry, bed slope, roughness and Reynolds number

7. Group-I contains dimensionless parameters and Group- II contains the ratios.
- | Group-I | Group -II |
|--------------------|--|
| P. Mach Number | 1. Ratio of inertial force and gravitational force |
| Q. Reynolds Number | 2. Ratio of fluid velocity and velocity of sound |
| R. Weber Number | 3. Ratio of inertial force and viscous force |
| S. Froude Number | 4. Ratio of inertial force and surface tension force |
8. The correct match of dimensionless parameters in Group- I with ratios in Group-II is:
(A) P-3, Q-2, R-4, S-1 (B) P-3, Q-4, R-2, S-1 (C) P-2, Q-3, R-4, S-1 (D) P-1, Q-3, R-2, S-4
9. The force exerted by a jet on a curved plate is
A). less than that on flat plate B). Equal to that on a flat plate
C).more than that on a flat plate
D).sometimes more and sometimes less than that on a flat plate
10. A normal shock wave
A) is reversible B) may occur in a converging tube C) is irreversible D) is isentropic
11. Cavitation is caused by
A) High velocity B) low barometric pressure C) Low pressure D) high pressure
12. unit power of a turbine is given by
A) $P/H^{1/2}$ B) $P/H^{3/2}$ C) $P/H^{3/4}$ D) $P/H^{5/2}$
13. Francis turbine is

A) an impulse turbine B) a reaction turbine C) a tangential flow turbine D) An impulse turbine

14. If hydro plant operate under a head of 100m, it may be classified as

A) a very high speed plant B) high head plant

C) Medium head plant D) low head plant

15. One of the river plant are usually

A) a very high speed plant B) high head plant

C) Medium head plant D) low head plan

16. A Double acting pump the theory of discharge is given by \

A) $Q=(2A-A_P)LN/60$ B) $(2A-A_P)LN/120$ C) $(2A-A_P)LN/90$ D) $(2A-A_P)LN/90$

17. A theoretical pump is

A) $ALN/60$ B) $ALN/30$ C) $ALN/120$ D) $ALN/180$

IES QUESTIONS:

1. Consider the following statements:

1. Hydraulically most efficient channel section for an open channel flow will carry maximum discharge for a given area of cross section.

2. For a given cross sectional area hydraulic radius maximum when the wetted perimeter is minimum. Which of the statements given above is/are correct?

a. 1 only b. 2 only c. Both 1 and 2 d. Neither 1 nor 2

2. A rectangular channel 3 m wide is laid on a slope of 0.0002. When the depth of flow in the channel is 1.5 m, what is the average boundary shear stress (nearly)?

a. 0.3 N/m² b. 0.15 N/m² c. 3.0 N/m² d. 1.5 N/m²

3. A right-angled triangular channel, symmetrical in section about the vertical, carries a discharge of 5 m³ /s with a velocity of 1.25 m/s. What is the approximate value of the Froude number of the flow?

a. 0.3 b. 0.4 c. 0.5 d. 0.615.

4. Which of the following equations are used for the derivation of the differential equation for water surface profile in open channel flow?

1. Continuity Equation 2. Energy Equation 3. Momentum Equation

Select the correct answer using the code given below

a. 1, 2 and 3 b. Only 1 and 3 c. Only I and 2 d. Only 2 and 3

5. Flow depths across a sluice gate are 2.0 m and 0.5 m. What is the discharge (per meter width)
 - a. 1.0 m²/s b. 1.4 m²/s c. 2.0 m²/s d. 2.8 m²/s
6. A rectangular channel is 6 m wide and discharges 30 m³ s⁻¹. The upstream depth is 2.0 m, acceleration due to gravity is 10 m s⁻². Then, what is the specific energy (approximate)?
 - a. 2.5 b. 0.3 c. 2.3 d. None of the above
7. Which one of the following statements is not correct?

A control section in an open channel is the site

 - a. where the flow quantity can be controlled b. at which flow is known to be critical
 - c. where the discharge can be measured d. where the specific energy is determined
8. What is the normal depth in a wide rectangular channel carrying 0.5 m²/s discharge at a bed slope of 0.0004 and Manning's n = 0.01 ?
 - a. 0.13 m b. 0.32 m c. 0.43 m d. 0.50 m
9. Flow happens at a critical depth of 0.5 m in a rectangular channel of 4 m width. What is the value of discharge?
 - a. 5.4 m³/s b. 5.1 m³/s c. 4.9 m³/s d. 4.4 m³/s
10. One end of a two dimensional water tank has the shape of quadrant of a circle of radius 2 meters. When the tank is full, the vertical component of the force per unit length of curved surface will be
 - a. 9.81πkN b. 19.62 πkN c. 29.43πkN d. 39.24πkN
11. A hydraulic jump occurs at the toe of a spillway. The depth before jump is 0.2 m. The sequent depth is 3.2 m. What is the energy dissipated in m (approximate)?
 - a. 27 b. 10.5 c. 15 d. 42
12. In a wide rectangular channel, an increase in the normal depth 20% corresponds to how much (approximate) increase in discharge?
 - a. 12% b. 20% c. 36% d. 48%
 - c. Head increases with speed d. Manometric head decreases with discharge
13. A penstock is 2000 m long and the velocity of pressure wave in it is 1000 m/s. Water hammer pressure head for instantaneous closure of valve at the downstream end of the pipe is 60 m. If the valve is closed in 4 s, then what is the peak water hammer pressure in m of water?
 - a. 15 b. 30 c. 60 d. 120
14. To generate 8100 kW under a head of 81 m while working at a speed of 540 r.p.m., what type of turbine is suitable?
 - a. Pelton b. Kaplan c. Bulb d. Francis

15. At a rated capacity of 44 cumec, a centrifugal pump develops 36 m of head
When operating at 725 r.p.m: What is its specific speed?
- a. 327 b. 255 c. 350 d. 45
16. Centrifugal pump should be installed above the water level in the sump such that
- a. Its height is not more than 10.3 m at room temperature of liquid
- b. Its height is not allowed to exceed 6.7m
- c. The negative pressure does not reach as low as the vapour pressure
- d. The negative pressure is not allowed to develop in the impeller
17. Which one of the following inferences is not drawn by studying performances curves of centrifugal pumps?
- a. Discharge increases with speed b. Power decreases with speed
- c. Head increases with speed d. Manometric head decreases with discharge
18. Centrifugal pump should be installed above the water level in the sump such that
- a. Its height is not more than 10.3 m at room temperature of liquid
- b. Its height is not allowed to exceed 6.7m
- c. The negative pressure does not reach as low as the vapour pressure
- d. The negative pressure is not allowed to develop in the impeller
19. In the selection of turbine by specific speed or head, which one of the following statements is not correct ?
- a. For specific speed 10—35, Kaplan turbines
- b. For specific speed 60—300, Francis turbines
- c. For head 50—1 50 m. Francis turbines d. For head above 300 m, Pelton wheel

XIII. WEBSITES:

- a. <http://nptel.iitm.ac.in/courses/IIT-MADRAS/Hydraulics/>
- b. <http://www.asce.org>
- c. <http://www.icivilengineer.com>
- d. <http://www.construction-guide.in>

EXPERT DETAILS:

1. Dr. B.S. Thandaveswara

Department of Civil Engineering , IIT Madras.

email: thand12345@yahoo.co.in

phone: 9894868380

2. Prof. B.S. Murty

Department of Civil Engineering, IIT Madras.

email: bsm@iitm.ac.in

phone: (91-44) 2257 4262

XV. JOURNALS:(NATIONAL & INTERNATIONAL)

0970-1141	Thesis Digest on civil Engineering	1987
0973-8061	International Engineering and Technology Journal of Civil and Structure	2007
0975-5314	International journal of civil engineering	2009
0975-6744	Journal of information knowledge and research in civil engineering	2009
0976-6308	International journal of civil engineering and technology	2010
2249-426X	International Journal of Civil Engineering and Applications	2011
2249-8753	Recent Trends in Civil Engineering and Technology	2011
2277-5986	World Research Journal of Civil Engineering	2011
2277-7032	International Journal of Structural and Civil Engineering	2012
2278-9987	International Journal of Civil Engineering (IJCE)	2012
2319-6009	International Journal of Structural and Civil Engineering Research	2012
2320-723X	International Journal of Advanced Research in Civil, Structural, Environmental and Infrastructure Engineering and Developing	2013

XVI. LIST OF TOPICS FOR STUDENT SEMINARS:

- Classification of Flows

- Open Channels
- Hydraulic Jump
- Hydraulic Turbines
- Centrifugal Pumps
- Hydropower Plants

XVII. CASE STUDIES / SMALL PROJECTS:

- Study of Open Channels
- Study of Hydro Turbines
- Study of Centrifugal Pumps
- Study of Hydropower plants