

FLUID MECHANICS-I

Subject Code: **CE303ES**

Regulations: **R17 - JNTUH**

Class : **II Year B.Tech CE I Semester**



Department of Civil Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

Ibrahimpattam - 501 510, Hyderabad

FLUID MECHANICS-I (CE303ES) COURSE PLANNER

I. COURSE OVERVIEW:

The aim of this course is to introduce basic principles of fluid mechanics and it is further extended to cover the application of fluid mechanics by the inclusion of fluid machinery. Nowadays the principles of fl

fluid mechanics find wide applications in many situations. The course deals with the fluid machinery, like turbines, pumps in general and in power stations. This course also deals with the large variety of fluids such as air, water, steam, etc; however the major emphasis is given for the study of water.

II. PREREQUISITE(S):

Level	Credit	Period	Prerequisite
UG	4	5	Engineering Physics, Thermodynamics, Engineering

III. COURSE OBJECTIVES:

The objectives of the course are to enable the student;

- I. To understand the basic principles of fluid mechanics
- II. To identify various types of flows
- III. To understand boundary layer concepts and flow through pipes
- IV. To evaluate the performance of hydraulic turbines
- V. To understand the functioning and characteristic curves of pumps.

IV. COURSE OUTCOMES:

At the end of this course, a student will be able to:

1. Explain the effect of fluid properties on a flow system.
2. Identify type of fluid flow patterns and describe continuity equation.
3. Analyze a variety of practical fluid flow and measuring devices and utilize fluid mechanics principles in design.
4. Demonstrate boundary layer concepts.
5. Explain the concept of Prandtl contribution.
6. Evaluate the Vonkarmen momentum integral equation.
7. Analyze the closed conduit flows using Renold’s experiment.
8. Analyze the laws of fluid friction using Darcy’s equation.
9. Evaluate the head losses in pipes.
10. Solve pipe network problems.

V. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency assessed by
PO1	General knowledge: An ability to apply the knowledge of mathematics, science and Engineering for solving multifaceted issues of Electrical Engineering	S	Assignments
PO2	Problem Analysis: An ability to communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems	N	Exercise
PO3	Design/Development of solutions: To develop Broad theoretical knowledge in Electrical Engineering and learn the methods of applying them to identify, formulate and solve practical problems involving electrical power	H	Assignments, Discussion
PO4	Conduct investigations of complex problems: An ability to apply the techniques of using appropriate technologies to investigate, analyze, design, simulate and/or fabricate/	H	Exercise

	commission complete systems involving generation, transmission and distribution of electrical energy		
PO5	Modern tool usage: An ability to model real life problems using different hardware and software platforms, both offline and real-time with the help of various tools along with upgraded versions.	N	-----
PO6	The engineer and society: An Ability to design and fabricate modules, control systems and relevant processes to meet desired performance needs, within realistic constraints for social needs	S	Exercise
PO7	Environment and sustainability: An ability To estimate the feasibility, applicability, optimality and future scope of power networks and apparatus for design of eco-friendly with sustainability	S	Discussion, Seminars
PO8	Ethics: To Possess an appreciation of professional, societal, environmental and ethical issues and proper use of renewable resources	N	Discussion, Seminars
PO9	Individual and team work: An Ability to design schemes involving signal sensing and processing leading to decision making for real time electrical engineering systems and processes at individual and team levels	S	Discussions
PO10	Communication: an Ability to work in a team and comprehend his/her scope of work, deliverables , issues and be able to communicate both in verbal ,written for effective technical presentation	S	Discussion, Seminars
PO11	Life-long learning: An ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	N	-----
PO12	Project management and finance: To be familiar with project management problems and basic financial principles for a multi-disciplinary work	S	Prototype, Discussions

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency assessed by
PSO 1	Professional Skills: An ability to understand the basic concepts in Electronics & Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	H	Lectures and Assignments
PSO 2	Problem-solving skills: An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	S	Tutorials
PSO 3	Successful career and Entrepreneurship: An understanding	S	Seminars

	of social-awareness & environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.		and Projects
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N - None

S - Supportive

H – Highly Related

VII. SYLLABUS:

JNTUH SYLLABUS

UNIT – I: INTRODUCTION

Dimensions and units – physical properties of fluids specific gravity, viscosity, surface tension, vapor pressure and their influences on fluid motion pressure at a point, Pascal’s law, Hydrostatic law – atmospheric, gauge and vacuum pressure measurement of pressure. Pressure gauges, Manometers: differential and Micro Manometers.

Hydrostatic forces on submerged plane, horizontal, vertical, inclined and curved surfaces – Center of pressure, Derivations and problems.

UNIT II: FLUID KINEMATICS

Description of fluid flow, stream line, path line, streak lines and stream tube. Classification of flows: Steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational and irrotational flows – Equation of continuity for one, two, three dimensional flows – stream and velocity potential functions, flow net analysis.

UNIT – III: FLUID DYNAMICS

Surface and body forces – Euler’s and Bernoulli’s equations for flow along a stream line for 3-D flow, (Navier stokes equations (Explanatory) Momentum equation and its application – forces on pipe bend. Pitot tube, Venturi meter and orifice meter – classification of orifices, flow over rectangular, triangular and trapezoidal and stepped notches – Broad crested weirs

UNIT –IV: BOUNDARY LAYER THEORY

Approximate solutions of Navier stokes equations – Boundary layer – concepts, Prandtl contribution, characteristics of boundary layer along a thin flat plate, vonkarmen momentum integral equation, laminar and turbulent boundary layers(no deviation), BL in transition, separation of BL, control of BL, flow around submerged objects – Drag and Lift – Magnus effect.

UNIT – V: CLOSED CONDUIT FLOW

Reynolds’s experiment – characteristics of Laminar & Turbulent flows. Flow between parallel plates, flow through long tube, flow through inclined tubes.

Laws of fluid friction – Darcy’s equation, Minor losses – pipes in series – pipes in parallel – Total energy line and hydraulic gradient line. Pipe network problems, variation of friction factor with Reynolds number – Moody’s chart.

SUGGESTED BOOKS:

TEXT BOOKS:

1. Fluid Mechanics by Modi and Seth, Standard Book House
2. A textbook of Fluid Mechanics and Hydraulic Machines by Dr. R.K. Bansal

3. Introduction to Fluid Machines by S.K. Som & G. Biswas (Tata McGraw-Hill Publishers Pvt. Ltd.)
4. Introduction to Fluid Machines by Edward J. Shaughnessy, Jr, Ira M. Katz and James P. Schaffer, Oxford University Press, New Delhi.

REFERENCE BOOKS:

1. Fluid Mechanics by J.F. Douglas, J.M. Gaserek and J.A. Swaffird
2. Fluid Mechanics by Frank. M. White (Tata McGraw-Hill Pvt.ltd)
3. Fluid Mechanics by A.K. Mohanty.
4. Fluid Mechanics and Machinery by D. Ramdurgaia

NPTEL WEB COURSE:

<http://nptel.ac.in/courses/112104118/>

NPTEL VIDEO COURSE:

<http://nptel.ac.in/courses/112104118/#>

GATE SYLLABUS:

Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, 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:

FLUID MECHANICS, OPEN CHANNEL FLOW, PIPE FLOW:

Fluid Properties, Pressure, Thrust, Buoyancy; Flow Kinematics; Integration of flow equations; Flow measurement; Relative motion; Moment of momentum; Viscosity, Boundary layer and Control, Drag, Lift; 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

VIII. COURSE PLAN:

Lecture No.	Week	Unit	Topics to be covered	Learning Objective	References
1.	1	1	UNIT-I Introduction, dimensions and units	Outline of various units	R4, T2
2.	1	1	Physical properties of fluids- specific gravity, viscosity, Surface tension, vapour pressure and their influence on fluid motion	Explain fluid properties	R4, T1
3.	1	1	Physical properties of fluids- specific gravity, viscosity, Surface tension, vapour pressure and their influence on fluid motion	Explain fluid properties	R4

4.	1	1	Physical properties of fluids- specific gravity, viscosity, Surface tension, vapour pressure and their influence on fluid motion	Explain fluid properties	R4
5.	2	1	Physical properties of fluids- specific gravity, viscosity, Surface tension, vapour pressure and their influence on fluid motion	Explain fluid properties	R4
6.	2	1	Atmospheric, gauge and vacuum pressures	Distinguish various pressures	R4
7.	2	1	Measurement of pressure- piezometer, U- tube and differential manometers	Determine pressure with different instruments	R4, T1, T2
8.	2	1	Measurement of pressure- piezometer, U- tube and differential manometers	Determine pressure with different instruments	R4, T1, T2
9.	3	1	Measurement of pressure- piezometer, U- tube and differential manometers	Determine pressure with different instruments	R4, T1, T2
10.	3	1	Measurement of pressure- piezometer, U- tube and differential manometers	Determine pressure with different instruments	R4, T1, T2
11.	3	2	Unit-II: Fluid Kinematics: Stream line, path line, streak line and stream tube	Differentiate various flow lines	R4, T2
12.	3	2	Fluid Kinematics: Stream line, path line, streak line and stream tube	Differentiate various flow lines	R4, T2
13.	4	2	Classification of flows- steady and unsteady, uniform and non uniform, laminar and turbulent, rotational and irrotational flows	Classify and describe various flows	R4, T1, T2
14.	4	2	Classification of flows- steady and unsteady, uniform and non uniform, laminar and turbulent, rotational and irrotational flows	Classify and describe various flows	R4, T1, T2
15.	4	2	Equation of continuity for one dimensional flow and three dimensional flows	Formulate continuity equation for 1 and 3- d flow	R4, T1
16.	4	2	Equation of continuity for one dimensional flow and three dimensional flows	Formulate continuity equation for 1 and 3- d flow	R4, T1
17.	5	3	UNIT-III-Fluid dynamics: Surface and body forces	List various forces	R4
18.	5	3	Euler's and Bernoulli's equations for flow along a stream line	Formulate Euler's and Bernoulli's equations	R4, T2

19.	5	3	Euler's and Bernoulli's equations for flow along a stream line	Formulate Euler's and Bernoulli's equations	R4, T2
20.	5	3	Euler's and Bernoulli's equations for flow along a stream line	Formulate Euler's and Bernoulli's equations	R4, T2
21.	6	3	Momentum equation and its application on force on pipe bend	Apply momentum equation for a pipe bend	R4, T2
22.	6	3	Momentum equation and its application on force on pipe bend	Apply momentum equation for a pipe bend	R4, T2
23.	6	3	BOUNDARY LAYER CONCEPTS: Definition, thickness, characteristics along thin plate	Define boundary layer	R4, T2
24.	6	3	Laminar and turbulent boundary layers (No derivation), boundary layer in transition	Distinguish boundary layer of laminar, turbulent and transition	R4, T2
25.	7	3	Laminar and turbulent boundary layers (No derivation), boundary layer in transition	Distinguish boundary layer of laminar, turbulent and transition	R4, T2
26.	7	3	Separation of boundary layer, submerged objects- drag and lift	Explain separation of boundary layer	R4, T1
27.	7	3	Separation of boundary layer, submerged objects- drag and lift	Explain separation of boundary layer	R4, T1
28.	7	3	Closed conduit flow: Reynolds's experiment	Demonstrate Reynold's experiment	R4
29.	8	3	Darcy Weisbach equation-minor losses in pipes	Formulate the Darcy's equation	T2
30.	8	3	Darcy Weisbach equation-minor losses in pipes	Formulate the Darcy's equation	T2
31.	8	3	Pipes in series and pipes in parallel	Discuss the series and parallel connections of pipes	R4, T1
32.	8	3	Pipes in series and pipes in parallel	Discuss the series and parallel connections of pipes	R4, T1
33.	9	3	Total energy line - hydraulic gradient line	Construct total energy and hydraulic gradient lines	R4, T1, T2
34.	9	3	Total energy line - hydraulic gradient line	Construct total energy and hydraulic gradient lines	R4, T1, T2

35.	9	3	Total energy line - hydraulic gradient line	Construct total energy and hydraulic gradient lines	R4, T1,T2
36.	9	3	Measurement of flow: Pitot tube, venture meter, and orifice meter, flow nozzle	Measure the discharge	R4, T2
37.	1 0	3	Measurement of flow: Pitot tube, venture meter, and orifice meter, flow nozzle	Measure the discharge	R4, T2
38.	1 0	3	Measurement of flow: Pitot tube, venture meter, and orifice meter, flow nozzle	Measure the discharge	R4, T2
39.	1 0	3	Measurement of flow: Pitot tube, venture meter, and orifice meter, flow nozzle	Measure the discharge	R4, T2
40.	1 0	4	UNIT – IV: Basics of Turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined vanes	Discuss the effect of hydrodynamic force on flat vanes	R4, T1
41.	1 1	4	Basics of Turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined vanes	Discuss the effect of hydrodynamic force on flat vanes	R4, T1
42.	1 1	4	Curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes	Draw the velocity triangles for Curved vanes	R4, T1,T2
43.	1 1	4	Hydraulic Turbines: classification of turbines, heads and efficiencies, impulse and reaction turbines	Classify the turbines	R4, T1,T2
44.	1 1	4	Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies	Evaluate the performance of turbines	R4, T1,T2
45.	1 2	4	Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies	Evaluate the performance of turbines	R4, T1,T2
46.	1 2	4	Hydraulic design-draft tube theory – functions and efficiency	Describe the functions of draft tube	R4, T2
47.	1 2	4	Hydraulic design-draft tube theory – functions and efficiency	Describe the functions of draft tube	R4, T2
48.	1 2	4	Hydraulic design-draft tube theory – functions and efficiency	Describe the functions of draft	R4

				tube	
49.	1 3	4	Hydraulic design-draft tube theory – functions and efficiency	Describe the functions of draft tube	R4
50.	1 3	4	Performance of hydraulic turbines: Geometric similarity, unit and specific quantities, characteristic curves	Define unit quantities and Draw characteristic curves	R4
51.	1 3	4	Performance of hydraulic turbines: Geometric similarity, unit and specific quantities, characteristic curves	Define unit quantities and Draw characteristic curves	R4
52.	1 3	4	Performance of hydraulic turbines: Geometric similarity, unit and specific quantities, characteristic curves	Define unit quantities and Draw characteristic curves	R4
53.	1 4	4	Governing of turbines, selection of type of turbine	Illustrate the governing of turbines	R4, T2
54.	1 4	4	Cavitation, surge tank, water hammer	Explain Cavitation, water hammer, surge tank	R4, T2
55.	1 4	5	UNIT-V:Centrifugal pumps: Classification, working, work done- barometric head losses and efficiencies	Classify and Explain the working of centrifugal pump	R4, T2
56.	1 4	5	Classification, working, work done- barometric head losses and efficiencies	Classify and Explain the working of centrifugal pump	R4, T2
57.	1 5	5	Classification, working, work done- barometric head losses and efficiencies	Classify and Explain the working of centrifugal pump	R4, T2
58.	1 5	5	Classification, working, work done- barometric head losses and efficiencies	Classify and Explain the working of centrifugal pump	R4, T2
59.	1 5	5	Specific speed – performance characteristic curves, NPSH.	Compare the characteristic curves of centrifugal pump	R4, T1,T2
60.	1 5	5	Specific speed – performance characteristic curves, NPSH.	Compare the characteristic curves of centrifugal pump	R4, T1,T2
61.	1 6	5	Reciprocating pumps: working, discharge, slip, indicator diagrams	Describe and Evaluate the performance of reciprocating pumps	R4, T1,T2
62.	1 6	5	Reciprocating pumps: working, discharge, slip, indicator diagrams	Describe and Evaluate the	R4, T1,T2

				performance of reciprocating pumps	
63.	1 6	5	Reciprocating pumps: working, discharge, slip, indicator diagrams	Describe and Evaluate the performance of reciprocating pumps	R4, T1,T2
64.	1 6	5	Reciprocating pumps: working, discharge, slip, indicator diagrams	Describe and Evaluate the performance of reciprocating pumps	R4, T1,T2

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

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I					H							S			
II					H										
III		H			H										H
IV	H	H	S											H	H
V			S		H										

N=None

S=Supportive H=Highly related

X. QUESTION BANK: (JNTUH)

DESCRIPTIVE QUESTIONS: (WITH BLOOMS PHRASES)

UNIT-I

SHORT ANSWER QUESTIONS-

S.N O	Question	Blooms Taxonomy Level	Programme Outcome
1	Define density, weight density.	Understanding	1
2	Define specific volume	Understanding	1
3	Define Newton's laws of viscosity.	Understanding	1
4	Define surface tension.	Understanding	1
5	Define compressibility.	Understanding	1
6	Define viscosity.	Understanding	1
7	Define vapour pressure.	Understanding	1

8	Define atmospheric gauge and vacuum pressure.	Understanding & remembering	1
9	Define compressible and incompressible fluid.	Understanding	1
10	Define and classify the manometers.	Understanding	1
11	Define specific gravity.	Understanding	1
12	Define Monometer	Understanding	1
13	Define Cohesion	Understanding	1
14	Define adhesion	Understanding	1
15	How are Fluids Classified?	Understanding	2
16	What are the units of Surface tension?	Understanding	2

LONG ANSWER QUESTIONS-

S. No	Question	Blooms Taxonomy Level	Program Outcome
1	State Newton's law viscosity and explain how viscosity varies with temperature for liquids and gases	Understanding & remembering	9
2	Derive an expression for surface tension on a liquid jet.	Analyze	9
3	Derive an expression for surface tension on a liquid droplet.	Analyze	9
4	How do you measure the pressure by using manometers and mechanical gauges?	Analyze & Apply	9
5	Prove that volumetric strain of a cylindrical rod which is subjected to an axial tensile load is equal to the strain in the length minus twice the strain if diameter.	Analyze & Apply	9
6	Why does the viscosity of a gas increases with the increases in temperature while that of a liquid decreases with increase in temperature?	Analyze & Apply	9
7	Calculate density, specific weight and weight of 1 liter of petrol of specific gravity 0.7	Analyze & Apply	9
8	State Newton's law viscosity and explain how viscosity varies with temperature for liquids and gases	Analyze & Apply	9
9	Explain the phenomenon of capillarity .Obtain an expression for capillarity rise of a fluid.	Analyze & Apply	9
10	Develop the expression for the relation between gauge pressure P inside a droplet of liquid and the surface tension.	Analyze & Apply	9

UNIT-2

SHORT ANSWER QUESTIONS-

S. N	Question	Blooms Taxonomy Level	Programme Outcome
1	Define path line, stream line, stream tube and streak line.	Understanding	9
2	Define steady and unsteady flows.	Understanding	9
3	Define rotational and ir-rotational flows.	Understanding & remembering	9
4	Define uniform and non uniform flows.	Understanding & remembering	9
5	Define and state the applications of momentum equation.	Understanding & remembering	9
6	Define laminar and turbulent flows.	Understanding & remembering	9
7	Define compressible and incompressible flows.	Understanding & remembering	9
8	Define the equation of continuity.	Understanding & remembering	9
9	Define the terms velocity potential and stream functions.	Understanding & remembering	9
10	Define the terms vertex, free vortex flows and forced vortex flows.	Understanding & remembering	9
11	Mention one difference between streamline and path line	Understanding	9
12	What are streak lines?	Understanding	9
13	What is one dimensional flow with example?	Understanding	9

LONG ANSWER QUESTIONS-

S. No	Question	Blooms Taxonomy Level	Programme Outcome
1	Sketch the flow pattern of an ideal fluid past a cylinder with circulation.	Understanding	12
2	Derive the condition for ir-rotational flow. Prove that for potential flow, both the stream function and velocity potential function must satisfy Laplace equation.	Understanding	12
3	Derive an expression for total pressure on a plane surface submerged in a liquid of specific weight with an inclination an angle θ .	Understanding	12
4	Obtain an expression for continuity equation for a 3-D Flow.	Analyze & Apply	12
5	Bring out the mathematical and physical	Analyze & Apply	12

	distinction between rotational and ir-rotational flows.		
6	Describe the use and limitations of flow nets	Analyze & Apply	12
7	Obtain an expression for continuity equation for a 1-D Flow	Analyze & Apply	12
8	Derive path line, stream line, and streak line.	Analyze & Apply	12
9	State the properties of stream function and prove each one of them.	Analyze & Apply	12
10	What is a stream tube and explain are its characteristics.	Analyze & Apply	12
11	Draw the flow pattern of a non- ideal fluid past a cylinder with rotation.	Analyze & Apply	12

UNIT-3

SHORT ANSWER QUESTIONS-

S. No	Question	Blooms Taxonomy Level	Programme Outcome
1	Name the different forces present in a fluid flow.	understanding	10
2	What is Euler's equation of motion.	understanding	10
3	What is venturimeter.	understanding	10
4	Define an orifice meter.	understanding	10
5	What is a pitot tube.	Understanding	10
6	Define moment of momentum equation.	understanding	10
7	Define continuity and Bernoulli's equation.	Remembering	10
8	What is a free jet of a liquid.	Understanding & evaluate	10
9	What are the different forms of energy in a flowing fluid.	Understanding & evaluate	2
10	Explain different types of pitot tubes.	Understanding	2
11	Give Energy Equation of an ideal Flow along a Streamline	Understanding & Evaluate	2

LONG ANSWER QUESTIONS-

S. No	Question	Blooms Taxonomy Level	Programme Outcome
1	Derive an expression for displacement thickness due to formation of boundary layer	Understanding	9
2	How do you distinguish sharp crested weir from a broad crested weir? Derive the expression for discharge over a sharp crested rectangular weir?	Analyze & Apply	9
3	For the Euler's equation of motion which forces	Analyze & Apply	9

	are taken into consideration.		
4	What is Euler's equation? How will you obtain Bernoulli's equation from it.	Analyze & Apply	9
5	Discuss the relative merits and demerits of venturimeter with respect to orifice meter.	Analyze & Apply	9
6	What is the difference between the pitot tube and pitot static tube.	Analyze & Apply	9
7	What is the difference between the momentum equation and impulse momentum equation.	Analyze & Apply	9
8	Derive Euler's equation of motion along a stream line for an ideal fluid and clearly the assumptions.	Analyze & Apply	9
9	Why is divergence more gradual than convergence in a venturimeter.	Analyze & Apply	9
10	Explain the principle of venturimeter with a neat sketch. derive the expression rate of flow of fluid through it.	Analyze & Apply	9

UNIT-4

SHORT ANSWER QUESTIONS-

S. No	Question	Blooms Taxonomy Level	Program me Out come
1	What do you understand by the terms boundary layer theory.	understanding	1
2	What is meant by boundary layer.	understanding	1
3	What do you mean by boundary layer separation.	remembering	1
4	Define displacement thickness.	remembering	1
5	What are the different methods of preventing the separating of boundary layers.	understanding	1
6	What is the effect of pressure gradient on boundary layer separation.	remembering	1
7	Define laminar boundary layer and turbulent boundary layer.	understanding	1
8	Define laminar sub layer and boundary layer thickness.	Understanding & remembering	1
9	Define lift.	Understanding & remembering	1
10	Define magnus effect.	Understanding	1

LONG ANSWER QUESTIONS-

S.	Question	Blooms	Programme
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No		Taxonomy Level	Out come
1	Derive an expression for displacement thickness due to formation of boundary layer.	Analyze & Apply	10
2	Explain with sketches the three methods of boundary layer control.	Analyze & Apply	10
3	Derive an expression for momentum thickness of boundary layer.	Analyze & Apply	10
4	Explain magnus effect and theory of lift for airfoils.	Analyze & Apply	10
5	Derive the expression for the energy and momentum correction factor	Analyze & Apply	10
6	What are the boundary conditions that must be satisfied by a given velocity profile in laminar boundary layer flows.	Understanding	10
7	Obtain Von karman momentum integral equation.	Understanding	10
8	Explain boundary layer separation? Mention few methods to prevent or delay the separation of boundary layer?	Evaluate	10
9	Derive Prandtl's boundary layer equation.	Evaluate	10
10	Derive expressions for boundary layer thickness ,boundary shear stress and friction drag in a turbulent boundary layer	Analyze & Apply	10

UNIT-5

SHORT ANSWER QUESTIONS-

S. No	Question	Blooms Taxonomy Level	Programme Out come
1	Define Reynold's experiment.	Understanding	6
2	What are the characteristics of laminar flows.	Remembering	6
3	What are the characteristics of turbulent flows.	Remembering & Understanding	6
4	What is the flow between parallel lines.	Remembering & Understanding	6
5	What are the laws of fluid friction.	Understanding	6
6	Define Darcy's equation.	Understanding	6
7	What are minor losses in pipes in series.	Understanding & remembering	6
8	What are minor losses in pipes in parallel.	Understanding	6
9	What is energy line.	Remembering & Understanding	6

10	What is hydraulic gradient line.	Understanding	6
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LONG ANSWER QUESTIONS-

S. No	Question	Blooms Taxonomy Level	Programme Outcome
1	Obtain the condition for maximum efficiency in transmission of power through pipeline	Analyze & Apply	15
2	Derive formulas for hydraulic gradient and total energy lines	Analyze & Apply	15
3	Derive the equation for head loss in pipes due to friction Darcy-Weisbach equation.	Analyze & Apply	15
4	What are the minor losses in pipes? Give the appropriate formulae to calculate the losses.	Analyze & Apply	15
5	What do you understand by turbulent flow? What factor decides the type of flow in pipes?	Apply	15
6	Derive an expression for the loss of head due to friction in pipes.	Analyze &	15
7	Derive Darcy-Weisbach equation.	Analyze & Apply	15
8	What is the velocity defect? Derive an expression for velocity defect in pipes?	Analyze & Apply	15
9	Why are the pipes connected in parallel.	Analyze & Apply	15
10	Explain what do you understand by hydraulic grade line and total energy line. Discuss its practical significance in analysis of fluid flow problems.	Analyze & Apply	15

XI. OBJECTIVE QUESTIONS: JNTUH

UNIT-1

- The SI unit of kinematic viscosity (ν) is:
(a) m^2/s (b) $\text{kg}/\text{m}\cdot\text{s}$ (c) m/s^2 (d) m^3/s^2
- Kinematic viscosity of air at 20°C is given to be $1.6 \times 10^{-5} \text{m}^2/\text{s}$. Its kinematic viscosity at 70°C will be vary approximately
(a) $2.2 \times 10^{-5} \text{m}^2/\text{s}$ (b) $1.6 \times 10^{-5} \text{m}^2/\text{s}$ (c) $1.2 \times 10^{-5} \text{m}^2/\text{s}$ (d) $3.2 \times 10^{-5} \text{m}^2/\text{s}$
- For a Newtonian fluid
(a) Shear stress is proportional to shear strain
(b) Rate of shear stress is proportional to shear strain
(c) Shear stress is proportional to rate of shear strain
(d) Rate of shear stress is proportional to rate of shear strain
- The dimension of surface tension is:
(a) ML^{-1} (b) L^2T^{-1} (c) ML^{-1}T^1 (d) MT^{-2}
- The dimensions of surface tension is:
(a) N/m^2 (b) J/m (c) J/m^2 (d) W/m

6. Assertion (A): In a fluid, the rate of deformation is far more important than the total deformation itself.
Reason (R): A fluid continues to deform so long as the external forces are applied.
(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is not the correct explanation of A
(c) A is true but R is false (d) A is false but R is true
7. Newton's law of viscosity depends upon the
(a) Stress and strain in a fluid (b) Shear stress, pressure and velocity
(c) Shear stress and rate of strain (d) Viscosity and shear stress
8. The shear stress developed in lubricating oil, of viscosity 9.81 poise, filled between two parallel plates 1 cm apart and moving with relative velocity of 2 m/s is:
(a) 20 N/m² (b) 196.2 N/m² (c) 29.62 N/m² (d) 40 N/m²
9. An oil of specific gravity 0.9 has viscosity of 0.28 Stokes at 380°C. What will be its viscosity in Ns/m²?
(a) 0.2520 (b) 0.0311 (c) 0.0252 (d) 0.0206

UNIT-2

1. In a two-dimensional velocity field with velocities u and v along the x and y directions respectively, the convective acceleration along the x -direction is given by _____.
2. The radial velocity v_r , at any radius r , when the gap width is h , is _____.
3. The radial component of the fluid acceleration at $r = R$ is _____.
4. For a fluid element in a two dimensional flow field (x - y plane), if it will undergo
(a) Translation only (b) Translation and rotation
(c) Translation and deformation (d) Deformation only
5. For a fluid element in a two dimensional flow field (x - y plane), if it will undergo
(a) Translation only (b) Translation and rotation
(c) Translation and deformation (d) Deformation only
6. A two-dimensional flow field has velocities along the x and y directions given by $u = x^2t$ and $v = -2xyt$ respectively, where t is time. The equation of streamlines is _____.
7. In adiabatic flow with friction, the stagnation temperature along a streamline
(a) Increases (b) Decreases (c) Remains constant (d) None
8. Streamlines, path lines and streak lines are virtually identical for
(a) Uniform flow (b) Flow of ideal fluids
(c) Steady flow (d) Non uniform flow
9. Circulation is defined as line integral of tangential component of velocity about a
(a) Closed contour (path) in a fluid flow (b) Open contour (path) in a fluid flow
(c) Closed or open contour (path) in a fluid flow (d) None
10. Existence of velocity potential implies that
(a) Fluid is in continuum (b) Fluid is irrotational
(c) Fluid is ideal (d) Fluid is compressible

UNIT-3

1. Bernoulli's equation can be applied between any two points on a streamline for a rotational flow field
(a) True (b) False (c) Insufficient data (d) Can't say
2. Navier Stoke's equation represents the conservation of
(a) Energy (b) Mass (c) Pressure (d) Momentum

3. In a venturimeter, the angle of the diverging section is more than that of converging section.
 (a) True (b) False (c) Insufficient data (d) Can't say
4. A venturimeter of 20 mm throat diameter is used to measure the velocity of water in a horizontal pipe of 40 mm diameter. If the pressure difference between the pipe and throat sections is found to be 30 kPa then, neglecting frictional losses, the flow velocity is:
 (a) 0.2 m/s (b) 1.0 m/s (c) 1.4 m/s (d) 2.0 m/s
5. Two balls of mass m and $2m$ are projected with identical velocities from the same point making angles 30° and 60° with the vertical axis, respectively. The heights attained by the balls will be identical.
 (a) True (b) False (c) None (d) Can't say
6. Which combination of the following statements about steady incompressible forced vortex flow is correct?
 P: Shear stress is zero at all points in the flow. Q: Vorticity is zero at all points in the flow
 R: Velocity is directly proportional to the radius from the centre of the vortex.
 S: Total mechanical energy per unit mass is constant in the entire flow field.
 (a) P and Q (b) R and S (c) P and R (d) P and S
7. A closed cylinder having a radius R and height H is filled with oil of density ρ . If the cylinder is rotated about its axis at an angular velocity of ω , then thrust at the bottom of the cylinder is _____.
8. Bernoulli's equation represents the
 (a) Forces at any point in the flow field and is obtained by integrating the momentum equation for viscous flows.
 (b) Energies at any point in the flow field and is obtained by integrating the Euler equations.
 (c) Momentum at any point in the flow field and is obtained by integrating them equation of continuity.
 (d) Moment of momentum and is obtained by integrating the energy equation.
9. Consider the following assumptions:
 A. The fluid is compressible. B. The fluid is inviscid.
 C. The fluid is incompressible and homogeneous.
 D. The fluid is viscous and compressible.
 The Euler's equation of motion requires assumptions indicated in :
 (a) 1 and 2 (b) 2 and 3 (c) 1 and 4 (d) 3 and 4
10. How is the velocity coefficient C_v , the discharge coefficient C_d , and the contraction coefficient C_c of an orifice related?
 (a) $C_v = C_c C_d$ (b) $C_c = C_v C_d$ (c) $C_d = C_c C_v$ (d) $C_c C_v C_d = 1$

UNIT -4

1. In a fully developed region of the pipe flow _____.
 (a) The velocity profile continuously changes from linear to parabolic shape
 (b) The pressure gradient remains constant in the downstream direction
 (c) The pressure gradient continuously changes exceeding the wall shear stress in the downstream direction The pipe is not running full
2. In a steady flow of oil in the fully developed laminar regime, the shear stress is:
 (a) Constant across the pipe
 (b) Maximum at the centre and decreases parabolically towards the pipe wall boundary

- (c) Zero at the boundary and increases linearly towards the centre.
 (d) Zero at the centre and increases towards the pipe wall.
- A 40 mm diameter 2m long straight uniform pipe carries a steady flow of water (viscosity 1.02 centipoises) at the rate of 3.0 liters per minute. What is the approximate value of the shear stress on the internal wall of the pipe?
 (a) 0.0166 dyne/cm² (b) 0.0812 dyne/cm² (c) 8.12 dyne/cm² (d) 0.9932 dyne/cm²
 - The pressure drop for a relatively low Reynolds number flow in a 600mm, 30m long pipeline is 70 kPa. What is the wall shear stress?
 (a) 0 Pa (b) 350 Pa (c) 700 Pa (d) 1400 Pa
 - The pressure drop in a 100 mm diameter horizontal pipe is 50 kPa over a length of 10 m. The shear stress at the pipe wall is:
 (a) 0.25 kPa (b) 0.125 kPa (c) 0.50 kPa (d) 25.0 kPa
 - Laminar developed flow at an average velocity of 5 m/s occurs in a pipe of 10 cm radius. The velocity at 5 cm radius is:
 (a) 7.5 m/s (b) 10 m/s (c) 2.5 m/s (d) 5 m/s
 - The power consumed per unit length in laminar flow for the same discharge, varies directly as D^n where D is the diameter of the pipe. What is the value of 'n'?
 (a) 1/2 (b) -1/2 (c) -2 (d) -4
 - A fully developed laminar viscous flow through a circular tube has the ratio of maximum velocity to average velocity as (a) 3.0 (b) 2.5 (c) 2.0 (d) 1.5
 - Which one of the following is the characteristic of a fully developed Laminar flow?
 (a) The pressure drop in the flow direction is zero
 (b) The velocity profile changes uniformly in the flow direction
 (c) The velocity profile does not change in the flow direction
 (d) The Reynolds number for the flow is critical
 - The MINIMUM value of friction factor 'f' that can occur in laminar flow through a circular pipe is:
 (a) 0.064 (b) 0.032 (c) 0.016 (d) 0.008

UNIT -5

- The thickness of laminar boundary layer at a distance 'x' from the leading edge over a flat varies as _____.
- The mass flow rate (in kg/s) across the section q – r is:
 (a) Zero (b) 0.05 (c) 0.10 (d) 0.15
- The integrated drag force (in N) on the plate, between p – s, is:
 (a) 0.67 (b) 0.33 (c) 0.17 (d) Zero
- Flow separation is caused by:
 (a) Reduction of pressure to local vapour pressure (b) A negative pressure gradient
 (c) A positive pressure gradient (d) Thinning of boundary layer thickness to zero.
- Consider a laminar boundary layer over a heated flat plate. The free stream velocity is U_∞ . At some distance x from the leading edge the velocity boundary layer thickness is $t \delta$. If the Prandtl number is greater than 1, then
 (a) $\partial V > \partial T$ (b) $\partial T > \partial V$ (c) $\partial V = \partial T$ (d) None of these
- In the boundary layer, the flow is:
 (a) Viscous and rotational (b) Inviscid and irrotational
 (c) Inviscid and rotational (d) Viscous and irrotational

7. In the region of the boundary layer nearest to the wall where velocity is not equal to zero, the viscous forces are:
 - (a) Of the same order of magnitude as the inertial forces
 - (b) More than inertial forces
 - (c) Less than inertial forces
 - (d) Negligible
8. The critical value of Reynolds number for transition from laminar to turbulent boundary layer in external flows is taken as:
 - (a) 2300
 - (b) 4000
 - (c) 5×10^5
 - (d) 3×10^6
9. The 'velocity defect law' is so named because it governs a
 - (a) Reverse flow region near a wall
 - (b) Slip-stream flow at low pressure
 - (c) Flow with a logarithmic velocity profile a little away from the wall
 - (d) Re-circulating flow near a wall
10. The hydrodynamic boundary layer thickness is defined as the distance from the surface where the
 - (a) Velocity equals the local external velocity
 - (b) Velocity equals the approach velocity
 - (c) Momentum equals 99% of the momentum of the free stream
 - (d) Velocity equals 99% of the local external velocity

XII. GATE QUESTIONS:

1. Jet pumps are often used in process industry for their
 - (a) High efficiency
 - (b) Easy maintenance
 - (c) Large capacity
 - (d) Capacity to transport gases, liquids and mixtures of both
2. Assuming ideal flow, the force F in Newton required on the plunger to push out the water is:
 - (a) 0
 - (b) 0.04
 - (c) 0.13
 - (d) 1.15
3. Neglect losses in the cylinder and assume fully developed laminar viscous flow throughout the needle; the Darcy friction factor is $64/Re$. where Re is the Reynolds number. Given that the viscosity of water is 1.0×10^{-3} kg/s m, the force F in Newton required on the plunger is:
 - (a) 0.13
 - (b) 0.16
 - (c) 0.3
 - (d) 4.4
4. For air near atmosphere conditions flowing over a flat plate, the laminar thermal boundary layer is thicker than the hydrodynamic boundary layer _____.
5. For flow of fluid over a heated plate, the following fluid properties are known: viscosity = 0.001 Pa.s; specific heat at constant pressure = 1kJ/kg.K; thermal conductivity = 1 W/m.K.
The hydrodynamic boundary layer thickness at a specified location on the plate is 1 mm. The thermal boundary layer thickness at the same location is:
 - (a) 0.001 mm
 - (b) 0.01 mm
 - (c) 1 mm
 - (d) 1000 mm
6. A fluid flowing over a flat plate has the following properties:

Dynamic viscosity: 25×10^{-6} kg/ms	Specific heat: 2.0 kJ/kgK
Thermal conductivity: 0.05 W/mk	

 The hydrodynamic boundary layer thickness is measured to be 0.5 mm.
The thickness of thermal boundary layer would be:
 - (a) 0.1 mm
 - (b) 0.5 mm
 - (c) 1.0 mm
 - (d) None of the above
7. Match List-I (Type of fluid) with List-II (Variation of shear stress) and select the correct answer:

List-I

- A. Ideal fluid
- B. Newtonian fluid
- C. Non-Newtonian fluid beyond shear
- D. Bingham plastic

Codes: A B C D

(a) 3 1 2 4

List-II

- 1. Shear stress varies linearly with the rate of strain
- 2. Shear stress does not vary linearly with the rate of strain
- 3. Fluid behaves like a solid until a minimum yield stress beyond which it exhibits a linear relationship between shear stress and the rate of strain
- 4. Shear stress is zero

A B C D

(b) 4 2 1 3

(c) 3 2 1 4

(d) 4 1 2 3

IES QUESTIONS:

1. If a piece of metal having a specific gravity of 13.6 is placed in mercury of specific gravity 13.6, then
 - (a) The metal piece will sink to the bottom
 - (b) The metal piece simply floats over the mercury with no immersion
 - (c) The metal piece will be immersed in mercury by half
 - (d) The whole of the metal piece will be immersed with its top surface just at mercury level.
2. A cylindrical piece of cork weighting 'W' floats with its axis in horizontal position in a liquid of relative density 4. By anchoring the bottom, the cork piece is made to float at neutral equilibrium position with its axis vertical. The vertically downward force exerted by anchoring would be:
 - (a) 0.5 W (b) W (c) 2W (d) 3 W
3. The components of velocity in a two dimensional frictionless incompressible flow are $u = t^2 + 3y$ and $v = 3t + 3x$. What is the approximate resultant total acceleration at the point (3, 2) and $t = 2$?
 - (a) 5 (b) 49 (c) 59 (d) 54
4. Which one of the following statements is correct? Irrotational flow is characterized as the one in which _____.
 - (a) The fluid flows along a straight line
 - (b) The fluid does not rotate as it moves along
 - (c) The net rotation of fluid particles about their mass centers remains zero.
 - (d) The streamlines of flow are curved and closely spaced
5. Two flows are specified as: (A) $u = y, v = - (3/2) x$ (B) $u = xy^2, v = x^2y$ Which one of the following can be concluded?
 - (a) Both flows are rotational
 - (b) Both flows are irrotational
 - (c) Flow A is rotational while flow B is irrotational
 - (d) Flow A is irrotational while flow B is rotational
6. The differential form of continuity equation for two-dimensional flow of fluid may be written in the following form $\square \frac{\partial u}{\partial x} + \square \square \frac{\partial v}{\partial y}$ in which u and v are velocities in the x and y-direction and ρ is the density. This is valid for
 - (a) Compressible, steady flow
 - (b) Compressible, unsteady flow
 - (c) Incompressible, unsteady flow
 - (d) Incompressible, steady flow

XIII. WEBSITES:

1. <http://www.asce.org>
2. <http://www.icivilengineer.com>
3. <http://www.construction-guide.in>
4. <http://nptel.ac.in/courses/112105171/1>

EXPERT DETAILS:

1. Vinayak Eswaran, Professor & Head of the Department, IIT Hyderabad
2. Dr.Raja Banerjee, Associate Professor, IIT Hyderabad
3. Dr.YVD Rao. Faculty In charge, Engineering Services Division, BITS Pilani, Hyderabad Campus
4. Dr. Jeevan Jaidi, Associate Professor, Dept. of Mechanical Engineering, BITS-Pilani, Hyderabad Campus
5. Dr P. Laxminarayana, Head, Dept. of Mechanical Engineering, Osmania University College of Engineering, Hyderabad
6. Dr. T.I. Eldho. Department of Civil Engineering, IIT Bombay

XV. JOURNALS:

- 1 Thesis Digest on civil Engineering
- 2 International Engineering and Technology Journal of Civil and Structure
- 3 International journal of civil engineering
- 4 Journal of information knowledge and research in civil engineering
- 5 International journal of civil engineering and technology
- 6 International Journal of Civil Engineering and Applications
- 7 Recent Trends in Civil Engineering and Technology
- 8 World Research Journal of Civil Engineering
- 9 International Journal of Structural and Civil Engineering
- 10 International Journal of Civil Engineering (IJCE)
- 11 International Journal of Structural and Civil Engineering Research
- 12 International Journal of Advanced Research in Civil, Structural, Environmental and Infrastructure Engineering and Developing

XVI. LIST OF TOPICS FOR STUDENT SEMINARS:

1. Drag
2. Lift
3. Dimensional Analysis
4. Modeling
5. Cavitations
6. Momentum and Energy principles in Open channel flow
7. Flow controls
8. Types of flow

XVII. CASE STUDIES / SMALL PROJECTS:

1. Fluid Mechanics in Braking Systems
2. Design Optimization of a Revolutionary Stable Salt Reactor
3. Designing Against Wind-loading - Prince Sultan Cultural Centre, Jeddah
4. Breakaway Coupling Optimization using CFD
5. Optimizing Fluid Mixing in a Fuel Injector Using CFD Analysis