INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	Fluid Dynamics				
Course Code	AAEB03				
Programme	B.Tech				
Semester	III	AE			
Course Type	Core				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mr. Shiva Prasad U, Assistant Professor				
Course Faculty	Dr. Govardhan D, Professor, Mr. Shiva Prasad U, Assistant Professor				

OBJECTIVES:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.
In line with this, faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process

COURSE OBJECTIVES

The course should enable the students to:

I	Illustrate about the basic properties of a fluid, hydrostatic forces on submerged bodies and different manometers.
II	Derive the basic principles of a fluid-continuity, momentum, Euler and Bernoulli's equations.

III	Explain the concept of boundary layer theory and importance of Prandtl’s boundary layer theory.
IV	Understand the flow through pipes and their losses for different geometries.

COURSE LEARNING OUTCOMES (COs):

CO 1	Understand the basic fluid properties and fluid dynamic concepts with its applications of fluid statics to determine forces of buoyancy and stability; and to fluids in rigid-body motion.
CO 2	Use of conservation laws in differential forms and Understand the dimensional methods and kinematics of fluid particles.
CO 3	Use Euler’s and Bernoulli’s equations and the conservation of mass to determine velocities, pressures, and accelerations for incompressible and inviscid fluids.
CO 4	Understand the concepts of viscous boundary layers, mechanics of viscous flow effects on immersed bodies and its forces.
CO 5	Apply principles of fluid mechanics to the operation, design, and selection of fluid machinery and to understand the ethical issues associated with decision making.

COURSE LEARNING OUTCOMES (CLOs):

AAEB03.01	Define the properties of fluids and its characteristics, which will be used in aerodynamics, gas dynamics, marine engineering etc.
AAEB03.02	Explain the hydrostatic forces on submerged bodies, variation with temperature and height with respect to different types of surfaces.
AAEB03.03	Define different types of manometers and explain buoyancy force, stability of floating bodies by determining its metacentre height.
AAEB03.04	Dimensional similarity and prediction of flow behaviour using dimensionless numbers.
AAEB03.05	Classification of fluid flows and governing equations of inviscid fluid flows.
AAEB03.06	Conceptual analysis of fluid flow and exact solutions of navier stokes equations for coquette flow and poiseuille flow.
AAEB03.07	Define Fluid forces and describe the motion of a fluid particle with fluid deformation.
AAEB03.08	Determine the Euler's and Bernoulli's equation and obtain its phenomenological basis of Naviers-stokes equation.
AAEB03.09	Describe about the flow measurements using different equipment’s of fluid flows.
AAEB03.10	Understand the Concept of boundary layer flows and control of flow separation.
AAEB03.11	Determine the flows over streamlined and bluff bodies to predict the drag and lift forces.
AAEB03.12	Understand the thickness factor with respect to Displacement, momentum and energy thickness.
AAEB03.13	Explain about the turbo machinery systems and working.
AAEB03.14	Describe the concepts of turbo machinery in the field of aerospace engineering and concepts of internal flows through engines.
AAEB03.15	Demonstrate the knowledge gained from the working of compressors, fans and pumps

TUTORIAL QUESTION BANK

MODULE I				
FLUID PROPERTIES AND FLUID STATICS				
Part - A (Short Answer Questions)				
S No	QUESTIONS	Blooms Taxonomy Level	Course Outcomes	Course Learning Outcomes (CLOs)
1	How the fluids are Classified?	Remember	CO1	AAEB03.01
2	Define specific volume and specific gravity.	Remember	CO1	AAEB03.01
3	Define Newton's laws of viscosity.	Remember	CO1	AAEB03.01
4	Define surface tension acting over fluids.	Remember	CO1	AAEB03.01
5	Define compressibility with respect to fluids.	Remember	CO1	AAEB03.01
6	Define viscosity of Newtonian and Non-Newtonian fluids	Remember	CO1	AAEB03.01
7	Define metacenter on a body immersed in fluids.	Remember	CO1	AAEB03.02
8	Define atmospheric gauge and vacuum pressure.	Remember	CO1	AAEB03.02
9	Define compressible and incompressible fluid.	Remember	CO1	AAEB03.02
10	Define and classify the manometers.	Remember	CO1	AAEB03.02
11	Why does the viscosity of a gas increases with the increases in temperature while that of a liquid decreases with increase in temperature?	Understand	CO1	AAEB03.02
12	One litre of crude oil weighs 9.6N.calculate its specific weight, density and specific gravity.	Remember	CO1	AAEB03.02
13	Define vapour pressure.	Understand	CO1	AAEB03.03
14	Define cavitation.	Remember	CO1	AAEB03.03
15	Define surface tension.	Understand	CO1	AAEB03.03
16	Define the property of capillarity.	Remember	CO1	AAEB03.03
17	Define kinematic viscosity and state its units.	Remember	CO1	AAEB03.03
18	Differentiate between compressible and in compressible fluids.	Remember	CO1	AAEB03.03
19	What is a piezometer?	Understand	CO1	AAEB03.03
20	Define differential manometer.	Understand	CO1	AAEB03.03
Part - B (Long Answer Questions)				
1	Discuss Newton's law viscosity and explain how viscosity varies with temperature for liquids and gases	Understand	CO1	AAEB03.01
2	A cube of side floats with one of its axes vertical in a liquid of specific gravity SL. If the specific gravity of the cube material is Sc, Calculate the values SL/Sc for the metacentre height to be zero.	Understand	CO1	AAEB03.01
3	A cylindrical log of specific gravity 0.425 is 5m long and 2m in diameter. Calculate to what depth the log will sink in fresh water with its axis being horizontal?	Understand	CO1	AAEB03.01
4	Develop an expression for surface tension on a liquid droplet.	Remember	CO1	AAEB03.01
5	Discuss how do you measure the pressure by using manometers and mechanical gauges?	Understand	CO1	AAEB03.01
6	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 in diameter.	Understand	CO1	AAEB03.02
7	Explain why does the viscosity of a gas increases with the increases in temperature while that of a liquid decreases with increase in temperature?	Understand	CO1	AAEB03.01
8	Calculate density, specific weight and weight of 1 liter of petrol of specific gravity 0.7.	Understand	CO1	AAEB03.02

9	Determine the meta centric height of the floating body by analytical method	Remember	CO1	AAEB03.02
10	Explain the phenomenon of capillarity. Obtain an expression for capillarity rise of a fluid.	Understand	CO1	AAEB03.02
11	Develop an expression for total pressure on a plane surface submerged in a liquid of specific weight with an inclination an angle θ.	Understand	CO1	AAEB03.02
12	An oil of specific gravity 0.80 is under a pressure of 137.2 kN/m^2. What is the pressure head expressed in metres of oil?	Understand	CO1	AAEB03.02
13	Define and explain why the following phenomena happen in fluids (i) spherical shape of a drop of liquid (ii) cavitation	Understand	CO1	AAEB03.02
14	How thick is the layer of liquid mud(specific gravity 1.6) at the bottom of a river with water 8 m deep, if there is a pressure of 343 kN/m^2 at the bottom of the mud? Treat the mud as a fluid	Understand	CO1	AAEB03.02
15	Two pipes are connected with an inverted U-tube differential manometer. Pipe A to the left limb and Pipe B to the right limb. Water is flowing through the pipes. The water level in the left limb connected to pipe A is 165cm. The difference of water level in the two limbs is 25cm and the level in the right limb is lower than that of the left limb. The difference of the level between two pipe centres is 50cm. Manometric fluid is the oil with specific gravity 0.9. Sketch the set up and determine the pressure difference between the pipes A and B.	Understand	CO1	AAEB03.03
16	How can you measure pressure by using differential manometers?	Understand	CO1	AAEB03.03
17	Explain different ways of expressing pressure and derive the relation between each other	Remember	CO1	AAEB03.03
18	Under what conditions is the miniscus between two liquids in a glass tube (i) concave upwards and (ii) concave downwards?	Understand	CO1	AAEB03.03
19	Define and Explain a fluid from mechanics point of view.	Remember	CO1	AAEB03.03
20	Explain in detail different types of fluids with a neat sketch of the graph	Understand	CO1	AAEB03.03
Part - C (Problem Solving and Critical Thinking Questions)				
1	A plate of certain oil weighs 40 KN. Calculate the specific weight, mass density and specific gravity of this oil.	Understand	CO1	AAEB03.01
2.	What is the intensity of pressure in the ocean at a depth of 1500m, assuming (a) salt water is incompressible with a specific weight of 10050 N/m^3 and (b) salt water is compressible and weighs 10050 N/m^3 at the free surface? E (bulk modulus of elasticity of salt water) = 2070 MN/m^2(constant).	Understand	CO1	AAEB03.01
3	A plate 0.0254 mm distant from a fixed plate, moves at 61cm/sec and requires a force of 0.2 kgf/m^2 to maintain this speed. Determine the dynamic viscosity of the fluid between the plates.	Understand	CO1	AAEB03.01
4	A rectangular plate of size 25 cm by 50 cm and weighing 25 kgf slides down a 30^o inclined surface at a uniform velocity of 2m/sec. If the uniform 2mm gap between the plate and the inclined surface is filled with oil determine the viscosity of the oil.	Remember	CO1	AAEB03.02
5	Calculate the capillary effect in mm in a glass tube 3mm in diameter when immersed in (a) water (b) mercury. Both the liquids are at 20^oC and the values of the surface tensions for water and mercury at 20^0c in contact with air are respectively	Remember	CO1	AAEB03.02

	0.0736 N/m and 0.51 N/m. Contact angle for water = 0^o and for mercury = 130^o.			
6	A rectangular pontoon of size 6m length, 3m width and 1.5 m height has a length of 0.95m in sea water of specific weight 10055 N/m^3. Determine its meta-centric height assuming it to have a uniform composition.	Understand	CO1	AAEB03.02
7	If the equation of a velocity profile over a plate is $V=2y^{2/3}$ in which V is the velocity in m/sec at a distance of y meters above the plate. Determine the shear stress at y=0 and y=0.075m given H = 0.835$N.S/m^2$.	Understand	CO1	AAEB03.03
8	Convert a pressure head of 100m of water to a) Kerosene of specific gravity 0.81 b) Carbon tetra chloride of specific gravity 1.6	Understand	CO1	AAEB03.03
9	A trapezoidal channel 2m wide at the bottom and 1m deep has side slopes 1:1. Determine: thetotal pressure and the center pressure on the vertical gate closing the channel when it is full of water.	Remember	CO1	AAEB03.03
10	A flat plate weighing 0.45KN has a surface area of 0.1m^2. It slides down an inclined plane at 30^0 to the horizontal at a constant speed of 3m/s. if the inclined plane is lubricated with an oil of viscosity 0.1Ns/m^2. Find the thickness of the oil film.	Understand	CO1	AAEB03.03
11	A rectangular plane surface 3m wide and 4m deep lies in water in such a way that its plane making an angle of 30^0 with the surface of water. Determine the total pressure force and position of center of pressure, when upper edge is 2m below the free surface.	Understand	CO1	AAEB03.03
MODULE -II				
FLUID KINEMATICS AND BASIC EQUATIONS OF FLUID FLOW ANALYSIS				
Part - A (Short Answer Questions)				
1	Define path line, streamline, stream tube and streak line.	Remember	CO2	AAEB03.04
2	What arrangements should be adopted to find the velocity at any point in a pipe by a pitot tube?	Understand	CO2	AAEB03.04
3	What is flow net in understanding fluid properties?	Understand	CO2	AAEB03.04
4	Define vortex flows.	Remember	CO2	AAEB03.04
5	Define and state the applications of momentum equation.	Remember	CO2	AAEB03.04
6	What is three-dimensional flow?	Remember	CO2	AAEB03.04
7	Define compressible and incompressible flows.	Remember	CO2	AAEB03.05
8	Define the equation of continuity.	Remember	CO2	AAEB03.05
9	Define the terms velocity potential and stream functions.	Remember	CO2	AAEB03.05
10	Define the terms free vortex flows and forced vortex flows.	Remember	CO2	AAEB03.05
11	Explain stream line flow pattern.	Understand	CO2	AAEB03.05
12	Explain path line flow pattern.	Remember	CO2	AAEB03.06
13	Explain streak line flow pattern	Understand	CO2	AAEB03.06
14	Explain stream tube	Remember	CO2	AAEB03.06
15	Differentiate steady and unsteady flow.	Understand	CO2	AAEB03.06
16	Differentiate uniform and non-uniform flow	Remember	CO2	AAEB03.06
17	Differentiate laminar and turbulent flow	Understand	CO2	AAEB03.06
18	Differentiate rotational and irrotational flow	Remember	CO2	AAEB03.06
19	Write the impulse momentum equation	Understand	CO2	AAEB03.06
20	Write the continuity equation for an incompressible, 1-D and steady flow.	Remember	CO2	AAEB03.06
Part - B (Long Answer Questions)				
1	Sketch the flow pattern of an ideal fluid past a cylinder with circulation.	Understand	CO2	AAEB03.04

2	Develop the condition for irrotational flow. Prove that for potential flow, both the stream function and velocity potential function must satisfy Laplace equation.	Remember	CO2	AAEB03.04
3	Explain the concepts of geometric, kinematic and Dynamic Similarities with the help of neat sketches.	Remember	CO2	AAEB03.04
4	Obtain an expression for continuity equation for a 3-D Flow.	Remember	CO2	AAEB03.04
5	List out the mathematical and physical distinction between rotational and irrotational flows.	Remember	CO2	AAEB03.04
6	Obtain an expression for mass and momentum for incompressible fluid flows.	Remember	CO2	AAEB03.04
7	Discuss about the Reynolds number as a very approximate measureof ratio of inertia force and viscous force.	Understand	CO2	AAEB03.04
8	Obtain the exact solutions of navier stokes equations for coquette flow and state the assumptions made.	Remember	CO2	AAEB03.05
9	Derive an expression of Euler's equation for assuming the fluid is inviscid.	Remember	CO2	AAEB03.05
10	Obtain the exact solutions of navier stokes equations for poiseuille flow and state the assumptions made.	Remember	CO2	AAEB03.05
11	Classify the patterns of flow and Explain in detail the path line flow and stream tube	Understand	CO2	AAEB03.05
12	Classify and Explain different types of forces acting on a fluid flow	Remember	CO2	AAEB03.05
13	State the principle of continuity equation. Derive the general 3-D continuity equation for a fluid flow.	Understand	CO2	AAEB03.05
14	State the principle of continuity equation.Derive the 1-D continuity equation for a fluid flow along a stream line flow	Remember	CO2	AAEB03.06
15	State the principle and Derive Bernoulli's equation for a fluid flow along a stream line.	Understand	CO2	AAEB03.06
16	State the assumptions of Bernoulli's equation and list the applications of Bernoulli's equation	Remember	CO2	AAEB03.06
17	State and derive the momentum equation. Also list out the applications of the equation.	Understand	CO2	AAEB03.06
18	Apply momentum equation to a pipe bend and derive expressions for forces acting on it.	Remember	CO2	AAEB03.06
19	Explain the terms fluid statics, fluid dynamics, fluid kinetics and fluid kinematics	Understand	CO2	AAEB03.06
20	Explain about the Reynolds experiment to determine the fluid flow types with the help of neat sketches.	Remember	CO2	AAEB03.06
Part - C (Problem Solving and Critical Thinking Questions)				
1	An open circular cylinder of 15cm diameter and 100cm long contains water up to a height of 70cm. Calculate the speed at which the cylinder is to be rotated about its vertical axis so that the axial depth becomes zero.	Remember	CO2	AAEB03.04
2	A vessel cylindrical in shape and closed at the bottom contains water up to a height of 80cm.the diameter of the vessel is 20cm and length of vessel is 120cm. the vessel is rotated at a speed of 400r.p.m about its vertical axis. Calculate the height of parabolic formed.	Remember	CO2	AAEB03.04
3	In a free cylindrical vortex flows at a point in the fluid at a radius of 200mm and a height of 100mm.The velocity and pressures are 10m/s and 117.72KN/m^2.find the pressure at a radius of 400mm and at a height of 200mm. the fluid is air having density equal to 1.24kg/m^3.	Remember	CO2	AAEB03.04

4	A uniform flow with a velocity of 20m/s is flowing over a source of strength $10m^2/s$. The uniform flow and source flow are in the same plane	Understand	CO2	AAEB03.04
5	A vessel cylindrical in shape and closed at the bottom and the top contains water at a height of 700mm. The dia of the vessel is 200mm and length of the vessel is 1.1m. Find the speed of rotation of the vessel if the axial depth of the water is Zero.	Understand	CO2	AAEB03.05
6	An open circular cylinder of 20cm dia and 100cm long contains water up to a height of 80cm. It is rotated about its vertical axis. Find the speed of rotation when there is no water spills and axial depth is Zero.	Understand	CO2	AAEB03.05
7	In a free cylindrical vortex flow of water at a point at a radius of 150mm the velocity and pressure are 5m/s and $14.715N/cm^2$. Find the pressure at a radius of 300mm.	Remember	CO2	AAEB03.05
8	If the cylindrical vessel of dia 15cm and length 100cm contains water at a height of 80cm is rotated at 950r.p.m. About its vertical axis, find the area uncovered at the base of the tank.	Remember	CO2	AAEB03.06
9	The velocity vector in a flow field is given as $V = 4x^3i - 10\ x_2yj + 2tk$. Determine the velocity and acceleration of a fluid particle at (2, 1, 3) at time=1.	Understand	CO2	AAEB03.06
10	A triangular gate which has a base of 1.5 m and an altitude of 2 m lies in a vertical plane. The vertex of the gate is 1 m below the surface in a tank which contains oil of specific gravity 0.8. Find the force exerted by the oil on the gate and the position of the center of pressure	Understand	CO2	AAEB03.06
MODULE -III				
FLUID DYNAMICS				
Part - A (Short Answer Questions)				
1	Describe the different forces present in a fluid flow.	Understand	CO3	AAEB03.07
2	Explain Euler’s equation of motion?	Understand	CO3	AAEB03.07
3	Describe the factors to be determined when viscous fluid flows through the circular pipe?	Understand	CO3	AAEB03.07
4	Identify the different forms of energy in a flowing fluid?	Understand	CO3	AAEB03.07
5	Discuss the range of Reynold’s number for laminar and turbulent flow in a pipe.	Understand	CO3	AAEB03.07
6	Define moment of momentum equation.	Remember	CO3	AAEB03.07
7	Define continuity and Bernoulli’s equation.	Remember	CO3	AAEB03.07
8	Define the concept of free jet of a liquid?	Understand	CO3	AAEB03.07
9	Discuss the importance of Buckingham’s π theorem.	Understand	CO3	AAEB03.08
10	Explain different types of Pitot tubes.	Understand	CO3	AAEB03.08
11	Name the forces present in a fluid flow.	Understand	CO3	AAEB03.08
12	For the Euler’s equation of motion which forces are taken into consideration?	Understand	CO3	AAEB03.08
13	What is venturi meter?	Understand	CO3	AAEB03.08
14	What is the difference between pitot-tube and pitot static tube?	Understand	CO3	AAEB03.08
15	How will you determine velocity at any point with the help of pitot tube?	Understand	CO3	AAEB03.09
16	List the engineering applications of Bernoulli’s theorem?	Remember	CO3	AAEB03.09
17	What are the different forms of energy in a flowing fluid?	Remember	CO3	AAEB03.09
18	State the different devices that once can use to measure the discharge through a pipe and also through an open channel.	Understand	CO3	AAEB03.09
19	Define vena contracta.	Understand	CO3	AAEB03.09

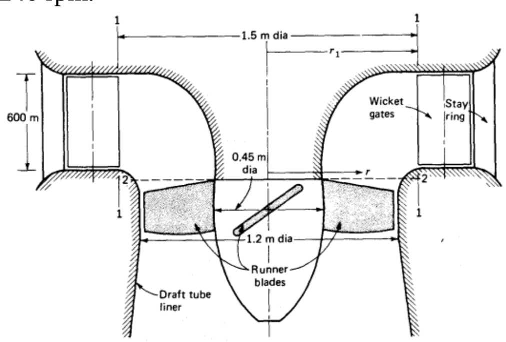
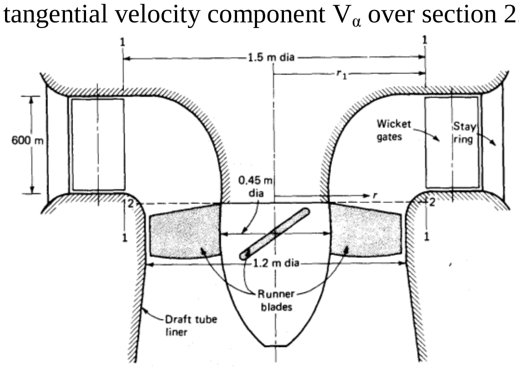
20	What is the difference between venture meter and orifice meter?	Understand	CO3	AAEB03.09
Part - B (Long Answer Questions)				
1	Explain the effect of forces in fluid dynamics and its importanc in having the governing equations of fluid dynamics.	Understand	CO3	AAEB03.07
2	State Bernoulli's theorem for compressible flow. Develop an expression for Bernoulli's equation when the process is (i) Isothermal and (ii) Adiabatic.	Remember	CO3	AAEB03.07
3	Explain the principle of venturi meter with a neat sketch. Derive the expression for the rate of the flow of flow through it.	Remember	CO3	AAEB03.07
4	What is Euler's equation? How will you obtain Bernoulli's equation from it?	Understand	CO3	AAEB03.07
5	Discuss the relative merits and demerits of Venturi meter with respect to Orifice meter.	Understand	CO3	AAEB03.07
6	Explain the difference between the pitot tube and pitot static tube.	Understand	CO3	AAEB03.07
7	Differentiate the importance between the momentum equation and impulse momentum equation?	Remember	CO3	AAEB03.07
8	Derive Euler's equation of motion along a stream line for an ideal fluid and clearly the assumptions.	Understand	CO3	AAEB03.07
9	Explain why divergence is more gradual than convergence in a Venturimeter?	Understand	CO3	AAEB03.08
10	A jet plane which weighs 29.43 kN and having a wing area of 20 m^2 flies at a velocity 950 km/hr, when the engine delivers 7357.5 kw power. 65% power is used to overcome the drag resistance of the wing. Calculate the coefficients of lift and drag for the wing. The density of the atmospheric air is 1.21kg/m^3.	Understand	CO3	AAEB03.08
11	What are the different forms of energy in a flowing fluid? Represent schematically the Bernoulli's equation for flow through a tapering pipe.	Understand	CO3	AAEB03.08
12	Write Euler's equation of motion along the stream line and integrate it to obtain Bernoulli's equation. State all the assumptions made.	Remember	CO3	AAEB03.08
13	Describe with the help of sketch the construction, operation and use of pitot-static tube.	Understand	CO3	AAEB03.08
14	Starting with Euler's equation of motion along a streamline, obtain Bernoulli's equation by its integration. List all assumptions made.	Understand	CO3	AAEB03.08
15	What are the advantages of triangular notch or weir over rectangular notch?	Understand	CO3	AAEB03.09
16	Derive an expression for the flow through triangular notch or weir and draw the suitable sketch.	Understand	CO3	AAEB03.09
17	Find the discharge over a triangular notch of angle 60deg when the head over the V-notch is 0.3m. Assume C_d = 0.6.	Remember	CO3	AAEB03.09
18	A sub-marine moves horizontally in sea and has its axis 20m below the surface of water. A pitot-static tube placed in front of sub-marine and along its axis, is connected to the two limbs of a u-tube containing mercury. The difference of mercury level is found to be 20cm. find the speed of sub-marine. Take sp.gr. of mercury 13.6 and of sea-level 1.026.	Understand	CO3	AAEB03.09

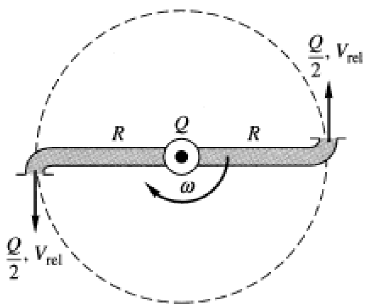
19	A horizontal venturimeter with inlet and throat diameters 30cm and 15cm respectively is used to measure the flow of water. The reading of differential manometer connected to inlet and throat is 10cm of mercury. Determine the rate of flow. Take $C_d = 0.98$.	Understand	CO3	AAEB03.09
20	Find the velocity of flow of an oil through a pipe, when the difference of mercury level in a differential U-tube manometer connected to two tappings of the pitot-tube is 15cm. Take sp. Gr. Of oil =0.8 and coefficient of pitot tube as 0.98.	Understand	CO3	AAEB03.09
	Part - C (Problem Solving and Critical Thinking Questions)			
1	When 2500 liters of water flows per minute through a 0.3m diameter pipe which later reduces to a 0.15 diameter pipe, Calculate the velocities of flow in the two pipes.	Understand	CO3	AAEB03.07
2	A pipe of dia 400mm carries water at a velocity of 25m/s. The pressures at a point are given as 29.43n/cm^2 and 22.563n/cm^2 while the datum head at A and B are 28m and 30m. Calculate the loss of head between A and B.	Understand	CO3	AAEB03.07
3	A horizontal venturi meter with inlet and throat and diameters 30cm and 15cm is used to measure the flow of water. The reading of differential manometer connected to the inlet and the throat is 20cm of mercury. Determine the rate of flow. Take $C_d = 0.98$.	Understand	CO3	AAEB03.07
4	Two velocity components are given in the following case, find the third component such that they satisfy the continuity equation. $U= x^3 + y^2+2z^2$ $V= -x^2y- yz -xy$	Remember	CO3	AAEB03.07
5	The velocity components in a two-dimensional flow field for an incompressible fluid are expressed as $U= y^3/3 + 2x-x^2y$ $v= xy^2-2y-x^3/3$. a) Show that these functions represent a possible case of an ir-rotational flow. b) Obtain an expression for stream function Ψ c) Obtain an expression for velocity potential Φ	Remember	CO3	AAEB03.08
6	For a three-dimensional flow field described by $V = (y^2+z^2)$: + $(x^2+z^2)j + (x^2+y^2)k$ find at (1,2,3). (i) the component of acceleration (ii) the components of rotation	Remember	CO3	AAEB03.08
7	In a straight uniform pipe, the discharge is reduced from 0.1 m^3/s to zero in 10seconds. If the cross-sectional area of the pipe is 200 sq. cm, state the nature and value of acceleration.	Understand	CO3	AAEB03.08
8	A nozzle is so shaped that the velocity of flow along the centerline changes linearly from 1-5 m/s to 15 m/s in a distance of 0.375. Determine the magnitude of the convective acceleration at the beginning and end of this distance.	Understand	CO3	AAEB03.09
9	In a 100mm diameter horizontal pipe a Venturimeter of 0.5 contraction ratio has been fixed the head of water on the meter when there is no flow is 3m. Find the rate of flow for which the throat pressure will be 2m of water absolute. Take atmospheric pressure head= 10.3m of water. The coefficient of meter is 0.97.	Remember	CO3	AAEB03.09
10	For a two-dimensional flow Φ = 3xy and x = 3/2 (y^2-x^2). Determine the velocity components at the points (1, 3) and (3,	Remember	CO3	AAEB03.09

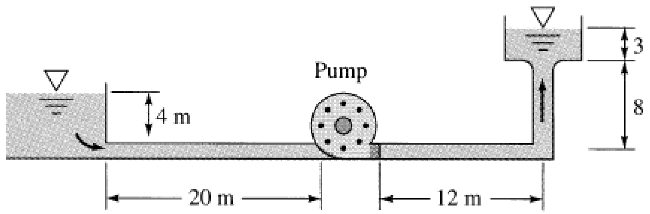
	3). Also find the discharge passing between the streamlines passing through the points given above.			
MODULE -IV				
BOUNDARY LAYER THEORY				
Part - A (Short Answer Questions)				
1	What do you understand by the terms boundary layer theory.	Understand	CO4	AAEB03.10
2	What is meant by boundary layer?	Understand	CO4	AAEB03.10
3	What do you mean by boundary layer separation?	Understand	CO4	AAEB03.10
4	Definedisplacementthickness in a boundary layer.	Remember	CO4	AAEB03.10
5	What are the different methods of preventing the separation of boundary layers?	Understand	CO4	AAEB03.10
6	Describe the effect of pressure gradient on boundary layer separation.	Remember	CO4	AAEB03.11
7	List the types of similarities or similitude used in model analysis.	Remember	CO4	AAEB03.11
8	Define laminar sub layer and boundary layer thickness.	Remember	CO4	AAEB03.11
9	Define dimensional homogeneity.	Remember	CO4	AAEB03.11
10	Define Froude Number and its applications.	Remember	CO4	AAEB03.11
11	What is flow nozzle?	Remember	CO4	AAEB03.12
12	Define drag.	Understand	CO4	AAEB03.12
13	Define lift.	Remember	CO4	AAEB03.12
14	What is the expression for boundary layer thickness	Understand	CO4	AAEB03.12
15	Sketch the boundary layer formation over the flat plate	Remember	CO4	AAEB03.12
16	Name the region at the end of the plate after boundary layer formation	Understand	CO4	AAEB03.12
17	Write the expression for momentum thickness	Remember	CO4	AAEB03.12
18	What is transition flow?	Understand	CO4	AAEB03.12
19	What is the condition for boundary layer separation	Understand	CO4	AAEB03.12
20	Write the condition of Reynolds's number for Laminar boundary layer region.	Understand	CO4	AAEB03.12
Part - B (Long Answer Questions)				
1	Develop an expression for displacement thickness due to formation of boundary layer.	Understand	CO4	AAEB03.10
2	Assuming the velocity distribution is laminar boundary layer along a flat plate is given by eq. Determine the displacement and energy thickness. u/U=2 y/δ-[y/δ]^2	Understand	CO4	AAEB03.10
3	Develop an expression for momentum thickness of boundary layer.	Understand	CO4	AAEB03.10
4	Explain Magnus effect and theory of lift for airfoils.	Understand	CO4	AAEB03.10
5	List the disadvantage of separation in fluid flow and explain how separation of flow can be controlled by(i) acceleration of flow in the boundary layer	Remember	CO4	AAEB03.10
6	What are the boundary conditions that must be satisfied by a given velocity profile in laminar boundary layer flows.	Understand	CO4	AAEB03.10
7	Discuss the development of boundary layer over a flat plate explaining laminar and turbulent boundary layer and establishment length.	Understand	CO4	AAEB03.10
8	Explain the phenomenon of boundary layer by considering a curved surface and state the conditions which lead to separation of boundary layer.	Remember	CO4	AAEB03.11
9	Developan expression for Prandtl's boundary layer equation by considering the suitable variables.	Understand	CO4	AAEB03.11

10	Develop expressions for boundary layer thickness, boundary shear stress and friction drag in a turbulent boundary layer	Understand	CO4	AAEB03.11
11	Mention few methods to prevent or delay the separation of boundary layer?	Understand	CO4	AAEB03.11
12	List the disadvantage of separation in fluid flow and explain how separation of flow can be controlled by suction of flow from the boundary layer.	Understand	CO4	AAEB03.11
13	Describe short notes on the separation of the boundary layer.	Remember	CO4	AAEB03.11
14	Differentiate between and energy and momentum thickness of the boundary layer.	Understand	CO4	AAEB03.12
15	How will you determine whether a boundary layer flow is attached flow, detached flow or on the verge of separation.	Understand	CO4	AAEB03.12
16	What is meant by boundary layer? Why does it increase with distance from the upstream edge?	Remember	CO4	AAEB03.12
17	How will you find the drag on a flat plate due to laminar and turbulent boundary layers?	Understand	CO4	AAEB03.12
18	What are the different forces acting on a fluid particle? Explain the significance ofbody forces and surface forces with appropriate sketches.	Understand	CO4	AAEB03.12
19	Derive Prandtl's boundary-layer equations for 2D steady, incompressible laminar flowsover a flat plate.	Understand	CO4	AAEB03.12
20	Discuss in detail about different zones/layers of turbulent flow past a wall with a neatsketch.	Understand	CO4	AAEB03.12
Part - C (Problem Solving and Critical Thinking Questions)				
1	A plate of 600mm length and 400mm wide is immersed in a fluid of specific gravity 0.9 and kinematic viscosity $v=10^{-4}m^{2/s}$. The fluid is moving with a velocity of 6m/s. Determine boundary layer thickness, shear stress at the end of the plate and drag force one side of the plate.	Understand	CO4	AAEB03.10
2	Air flows at 10m/s past a smooth rectangular flat plate 0.3m wide and 3m long. Assuming that's the turbulence level in the oncoming stream is low and that transition occurs at $R_e=5 \times 10^5$, Calculate ratio of total drag when the flow is parallel to the length of the plate to the value when the flow is parallel to the width.	Understand	CO4	AAEB03.10
3	Oil with a free stream velocity of 2m/s flows over a thin plate 2m wide and 2m long. Calculate the boundary layer thickness and the shear stress at the trailing end point and determine the total surface resistance of the plate. Take specific gravity 0.86 and kinematic viscosity 10^{-5} m^2/s.	Understand	CO4	AAEB03.10
4	A thin plate is moving in still atmospheric air at a velocity of 4m/s. The length of plate is 0.5m and width is 0.4m, calculate the thickness of boundary layer at the end of the plate and the drag force on one side of the plate. Take density of air is 1.25Kg/m^3 and kinematic viscosity 0.15 stokes.	Remember	CO4	AAEB03.11
5	A smooth flat plate of size 8 m by 1.5m is towed in a liquid of density 900kg/ m^3 and viscosity 0.12 poises at a uniform velocity of 3.5 m/s. The motion is parallel to the 6 m side of the plate. What is the length of the plate over which the boundary layer is laminar? Calculate the surface drag on both sides of plate.	Remember	CO4	AAEB03.11
6	Oil with a free stream velocity of 3m/s flows over a thin plate 2m wide and 2m long. Calculate the boundary layer thickness and the shear stress at the trailing end point and determine the	Remember	CO4	AAEB03.11

	total surface resistance of the plate. Take specific gravity 0.89 and kinematic viscosity 10^{-5} m^2/s.			
7	In a stream of oil of specific gravity 0.95 and kinetic viscosity 0.92 stoke moving at 5.75 m/s, a plate of 500mm length and 250mm width is placed parallel to the direction of motion. Calculate the friction drag on one side of plate. Also, find the thickness of the boundary layer and the shear stress at the trailing edge of the plate.	Understand	CO4	AAEB03.11
8	A smooth flat plate of size 30 cm X 60 cm is placed in a stream of water of uniform velocity 60 cm/sec. Flow takes parallel to the 30 cm length of the plate. If the kinematic viscosity of water is 0.011 stoke, is the boundary layer formed on the plate laminar or turbulent? Determine the shear stress at the trailing edge, maximum boundary layer thickness, mean drag coefficient and the work done by the fluid on one side of the plate per unit time in Joules.	Understand	CO4	AAEB03.12
9	A stream lined train is 350 m long and has an average cross-section with a perimeter of 110.2 m above the wheels. Assuming that the boundary layer is completely turbulent, compute the surface drag for a speed of 120 mph and power required to overcome this drag. Dynamic viscosity of air = 0.000185 poise and specific weight = 12 N/m^3.	Understand	CO4	AAEB03.12
10	A smooth flat plate of size 6 m by 3m is towed in a liquid of density 900kg/ m^3 and viscosity 0.12 poises at a uniform velocity of 2.5 m/s. The motion is parallel to the 6 m side of the plate. What is the length of the plate over which the boundary layer is laminar? Calculate the surface drag on both sides of plate.	Understand	CO4	AAEB03.12
MODULE -V				
TURBO MACHINERY				
Part - A (Short Answer Questions)				
1	What are called turbines?	Understand	CO5	AAEB03.13
2	What is known as Euler's equation for turbo-machines?	Remember	CO5	AAEB03.13
3	Define compressor used in turbo machinery.	Remember	CO5	AAEB03.13
4	What is the use of velocity triangles?	Understand	CO5	AAEB03.13
5	Define Hydraulic efficiency.	Remember	CO5	AAEB03.13
6	Define Mechanical efficiency.	Understand	CO5	AAEB03.13
7	What are an impulse turbine and a reaction turbine?	Understand	CO5	AAEB03.13
8	Define cavitation and its importance.	Remember	CO5	AAEB03.14
9	Classify the fluid machine types?	Remember	CO5	AAEB03.14
10	Define Impulse Momentum Equation (or) Momentum Equation.	Understand	CO5	AAEB03.14
11	Define Net head of a turbine.	Understand	CO5	AAEB03.14
12	What are the efficiencies of a turbine?	Remember	CO5	AAEB03.14
13	Write the equation for Euler turbo machine?	Remember	CO5	AAEB03.15
14	Define volumetric efficiency.	Understand	CO5	AAEB03.15
15	Define Overall efficiency.	Remember	CO5	AAEB03.15
16	Define Jet Ratio.	Remember	CO5	AAEB03.15
17	Classification of hydraulic turbines	Remember	CO5	AAEB03.14
18	Define Radial flow reaction turbine and theirtypes.	Remember	CO5	AAEB03.15
19	What is a reciprocating pump?	Remember	CO5	AAEB03.15
20	What is single acting pump and double acting pump?	Understand	CO5	AAEB03.15

Part - B (Long Answer Questions)				
1	Explain Performance analysis of turbine	Understand	CO5	AAEB03.13
2	The reaction turbines at the Srisailam dam installation have rated capacity of 115000hp at 180rpm under a head of 487ft. The diameter of each turbine is 11ft and the discharge is 2350cfs. Evaluate the speed factor, the unit speed, unit discharge and unit power, and the specific speed.	Understand	CO5	AAEB03.13
3	Discuss Performance analysis of compressor used in fluid machinery applications.	Understand	CO5	AAEB03.13
4	A centrifugal pump has r_2 =9 in, b_2 =2 in, and β_2 =35° and rotates at 1060 r/min. If it generates a head of180 ft, determine the theoretical(a) flow rate in gal/minand (b) horsepower. Assume near-radial entry flow.	Understand	CO5	AAEB03.13
5	A turbine model test with 250 mm diameter impeller showed an efficiency of 90%. What efficiency could be expected from 1.5m diameter impeller?	Understand	CO5	AAEB03.13
6	Assuming uniform axial velocity over section 2 of fig. using fig data, determine the angle of the leading edge of the propeller at r =0.225,0.45, and 0.6m for a propeller speed of 240 rpm. 	Understand	CO5	AAEB03.13
7	The wicket gates of the propeller turbine of fig. are turned so that the flow makes an angle of 45^o with a radial line at section 1, where the speed is 4.005 m/s. Determine the magnitude of tangential velocity component V_α over section 2. 	Understand	CO5	AAEB03.13
8	What are the minor losses in pipes? Give the appropriate formulae to calculate the losses.	Understand	CO5	AAEB03.14
9	What would be the technical classification of the following turbo machines: (a) a household fan, (b) a windmill,(c) an aircraft propeller, (d) a fuel pump in a car,(e) an eductor, (f) a fluid-coupling transmission, and (g)a power plant steam turbine?	Understand	CO5	AAEB03.14
10	A lawn sprinkler can be used as a simple turbine. As shown in Fig., flow enters normal to the paper in the centre and splits	Understand	CO5	AAEB03.14

	evenly into $Q/2$ and V_{rel} leavingeach nozzle. The arms rotate at angular velocity and do work on a shaft. Draw the velocity diagram for this turbine. Neglecting friction, find an expression for the powerdelivered to the shaft. Find the rotation ratefor which the power is a maximum. 			
11	Prove that the forces exerted by fluid on a body is equal to the Rate of momentum in minus the Rate of momentum out.	Understand	CO5	AAEB03.14
12	How would you predict the cascade losses in a stage from its velocity triangles?	Understand	CO5	AAEB03.14
13	How would you predict the flow losses in a pump, make use of sketches and plots to predict the same.	Understand	CO5	AAEB03.14
14	Evaluate the Performance of fan used in fluid machinery systems and evaluate the characteristics.	Understand	CO5	AAEB03.15
15	How would you predict the blade losses in a stage from its velocity triangles?	Understand	CO5	AAEB03.15
16	Evaluate the Performance of burner used in fluid machinery systems and evaluate the characteristics.	Understand	CO5	AAEB03.15
17	A turbine model test with 300 mm diameter impeller showed an efficiency of 90%. What efficiency could be expected from 1.3m diameter impeller?	Understand	CO5	AAEB03.15
18	Evaluate the Performance of turbine used in fluid machinery systems and evaluate the characteristics.	Understand	CO5	AAEB03.15
19	What would be the technical classification of the following turbo machines: (a) a fuel pump in a car, (b) an eductor, (c) a fluid-coupling transmission, and (d)a power plant steam turbine?	Understand	CO5	AAEB03.15
20	Evaluate the Performance of exhaust nozzle used in fluid machinery systems and evaluate the characteristics.	Understand	CO5	AAEB03.15
Part - C (Problem Solving and Critical Thinking Questions)				
1	A typical household basement sump pump provides adischarge of 5 gal/min against a head of 15 ft. Estimate (a) the maximum efficiency and (b) the minimum horsepowerrequired to drive such a pump at 1750 r/min.	Understand	CO5	AAEB03.13
2	An axial-flow pump delivers 40 ft^3/s of air which enters at 20^0C and 1 atm. Theflow passage has a 10-in outer radius and an 8-in inner radius. Blade angles are $\alpha 1 = 60^0$ And$\beta 2 = 70^0$, and the rotor runs at 1800 rpm. For the first stage, compute (a) the headrise; and (b) the power required.	Understand	CO5	AAEB03.13
3	Water is flowing through a rough pipe of diameter 600mm at the rate 600liters/sec. the wall roughness is 3mm. find the power lost for 1km length of pipe.	Understand	CO5	AAEB03.13
4	It is proposed to run the pump of at 880r/min to pump water at 20°C through the system in Fig. P11.66.The pipe is 20-cm-diameter commercial steel. What flowrate in ft3/min will	Remember	CO5	AAEB03.14

	result? Is this an efficient application? 			
5	A compound piping system consists of 1800m of 0.50m, 1200m of 0.40m and 600m of 0.30m new cast iron pipes connected in series. Convert the system to (a) an equivalent length of 0.40m pipe and (b) Equivalent size pipe 3600m long.	Understand	CO5	AAEB03.14
6	An idealized radial turbine isshown in Fig. P11.90. The absolute flow enters at 25m/s with the blade angles asshown. The flow rate is 8 m^3/s of water at20^{0}C. The blade thickness is constant at20 cm. Compute the theoretical power developedat 100% efficiency.	Remember	CO5	AAEB03.14
7	A pipeline 0.225 m in diameter and 1580m long has a slope of 1 in 200 for the first 790m and 1 in 100 for the next 790m. The pressure at the upper end of the pipeline is 107.91 kpa and at the lower end is 53.955kpa. Taking f=0.032 determine the discharge through the pipe.	Understand	CO5	AAEB03.15
8	The velocities of water through a pipe of diameter 10cm are 4m/s and 3.5m/s at the center of the pipe and 2cm from the pipe center. Determine the wall shearing stress in the pipe for turbulent flow.	Understand	CO5	AAEB03.15
9	Determine the average height of the roughness for a rough pipe of diameter 10cm when the velocity at a point 4cm from wall is 40% more than the velocity at a point 1cm from pipe wall.	Understand	CO5	AAEB03.15
10	For turbulent flow in a pipe diameter 300mm, find the discharge when the center line velocity is 2m/s and the velocity at a point 100mm from the center as measured by pivot tube is 1.6m/s.	Remember	CO5	AAEB03.15

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