# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**
Dundigal, Hyderabad -500 043

## CIVIL ENGINEERING

### TUTORIAL QUESTION BANK

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| **Course Name** | : | **FLUID MECHANICS** |
| **Course Code** | : | **ACE005** |
| **Class** | : | IV Semester |
| **Branch** | : | CE |
| **Year** | : | 2018-19 |
| **Course Coordinator** | : | Dr. G.V. Ramana, Professor and Head, Civil Engineering Department. |
| **Course Faculty** | : | Dr. G.V. Ramana, Professor and Head, Civil Engineering Department.<br>Mr. CH.V.S.S. Sudheer, Asst.Professor, Civil Engineering Department |

**COURSE OBJECTIVES:**

**The course should enable the students to:**

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| **I** | Understand and study the effect of fluid properties on a flow system |
| **II** | Apply the concept of fluid pressure, its measurements and applications. |
| **III** | Explore the static, kinematic and dynamic behavior of fluids. |
| **IV** | Assess the fluid flow and flow parameters using measuring devices. |

**COURSE LEARNING OUTCOMES:**

**Students, who complete the course, will have demonstrated the ability to do the following:**

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| CACE005.01 | Define fluid and its properties. Describe effect of temperature on viscosity. |
| CACE005.02 | Explain Newton's law of viscosity. Classify fluids based on Newton's law of viscosity and solve problems on Viscosity. |
| CACE005.03 | Employ capillary principle to calculate capillary rise/fall in a given tube. |
| CACE005.04 | Interpret different forms of pressure measurement. |
| CACE005.05 | Employ principle of manometry to measure gauge and differential pressure. Define Pascal's law. |
| CACE005.06 | Calculate Hydrostatic Force and its Location for a given geometry and orientation of plane surface |
| CACE005.07 | Examine the possibility of a flow using continuity equation |
| CACE005.08 | Employ Archimedes principle to solve numerical examples on Buoyancy |
| CACE005.09 | Identify and interpret different flows with relevant equations |
| CACE005.10 | Distinguish velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow |
| CACE005.11 | Examine stability of a floating body by determining its metacentric height |
| CACE005.12 | Establish Euler's theorem and deduce Bernoulli's equation for a ideal fluid and comment on validation assumption made. |
| CACE005.13 | Examine Bernoulli's equation for ideal and real fluids and evaluate the direction of flow |
| CACE005.14 | Distinguish between major loss and minor loss. |
| CACE005.15 | Employ Darcy-Weichbach and Chezy's equation to calculate friction losses |
| CACE005.16 | Interpret different pipe fittings and evaluate the fluid velocity considering major and minor losses |
| CACE005.17 | Sketch HGL and TEL for a given pipe setting. |
| CACE005.18 | Distinguish between Drag force and lift force and Examine drag and lift force for a given set of dimension and variables |

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| CACE005.19 | Write the boundary layer concept. |
| CACE005.20 | Distinguish displacement, momentum, and energy thickness |
| CACE005.21 | Explain the concept of prandtl contribution. |
| CACE005.22 | Evaluate the Vonkarmen momentum integral equation. |
| CACE005.23 | Analyze the closed conduit flows using Renold's experiment. |
| CACE005.24 | Possess the knowledge and skills for employability and to succeed in national and international level competitive examinations. |

| S.No. | QUESTIONS | Blooms Taxonomy Level | Course Learning Outcomes |
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| **UNIT - I** | | | |
| **INTRODUCTION** | | | |
| **Part - A (Short Answer Questions)** | | | |
| 1 | Define density, weight density. | Understand | CACE005.01 |
| 2 | Write the relation between density and specific volume | Remember | CACE005.01 |
| 3 | What is Newton's law of viscosity? | Understand | CACE005.01 |
| 4 | State surface tension, Cohesion. | Remember | CACE005.02 |
| 5 | Define compressibility. | Understand | CACE005.02 |
| 6 | Write the units of viscosity and kinematic viscosity. | Remember | CACE005.02 |
| 7 | Define vapour pressure. | Understand | CACE005.02 |
| 8 | Differentiate atmospheric gauge and vacuum pressure. | Remember | CACE005.02 |
| 9 | Define compressible and incompressible fluid. | Understand | CACE005.03 |
| 10 | What is Buoyancy and meta-centric height? | Remember | CACE005.03 |
| 11 | List out specific gravity of water, mercury, and $ccl_4$. | Understand | CACE005.03 |
| 12 | State Pascal's law. | Remember | CACE005.03 |
| 13 | How is Fluids Classified based on Newton laws of Viscosity? | Understand | CACE005.04 |
| 14 | Differentiate adhesion and cohesion | Remember | CACE005.04 |
| 15 | Define and classify the manometers. | Understand | CACE005.04 |
| 16 | What do you understand by 'Total Pressure' and 'Centre Pressure'? | Understand | CACE005.04 |
| 17 | Give the relation for pressure inside a water droplet | Remember | CACE005.05 |
| 18 | How does the vapour pressure vary with the temperature? | Understand | CACE005.05 |
| 19 | What is manometer? How they are classified? | Remember | CACE005.05 |
| 20 | List out Newtonian and Non-Newtonian Fluids? | Understand | CACE005.05 |
| **Part - B (Long Answer Questions)** | | | |
| 1 | State Newton's law viscosity and explain how viscosity varies with temperature for liquids and gases. | Understand | CACE005.01 |
| 2 | Derive an expression for surface tension on a liquid jet. | Remember | CACE005.01 |
| 3 | Derive an expression for surface tension on a liquid droplet. | Understand | CACE005.01 |
| 4 | How do you measure the pressure by using manometers and mechanical gauges? | Remember | CACE005.02 |
| 5 | Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface sub-merged in the liquid. | Understand | CACE005.02 |
| 6 | Why does the viscosity of a gas increases with the increases in temperature? While that of a liquid decreases with increase in temperature? | Remember | CACE005.02 |

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| 7 | Calculate density, specific weight and weight of 1 litre of petrol of specific gravity 0.7 | Remember | CACE005.02 |
| 8 | State Newton's l a w viscosity a n d derive the relation for the shear stress and viscosity. | Understand | CACE005.02 |
| 9 | Explain the phenomenon of capillarity .Obtain an expression for capillarity rise of a fluid. | Understand | CACE005.03 |
| 10 | Develop the expression for the relation between gauge pressure P inside a droplet of liquid and the surface tension. | Remember | CACE005.03 |
| 11 | State Newton's third law of motion and summarize how viscosities of liquids differ with temperature for particles in liquid state and gaseous state. | Understand | CACE005.03 |
| 12 | Derive an expression for the force exerted on a sub-merged vertical plane surface by the static liquid and locate the position of centre of pressure. | Remember | CACE005.03 |
| 13 | Prove that the centre of pressure of a completely sub-merged plane is always below the centre of gravity of the sub-merged surface or at most coincide with the centre of gravity when the plane surface is horizontal. | Understand | CACE005.04 |
| 14 | Write the procedure for determining/measuring pressures by monometers and mechanical gauges. | Remember | CACE005.04 |
| 15 | Obtain the relation with parameter like volumetric strain of cylindrical rod, its strain and diameter strain in case of a cylindrical rod subjected to axial tensile load. | Understand | CACE005.04 |
| 16 | Explain the phenomenon of temperature changes in viscosities of a liquid and gas | Remember | CACE005.04 |
| 17 | Explain how you would find the resultant pressure on a curved surface immersed in a liquid. | Understand | CACE005.05 |
| 18 | Derive the expression for capillary rise of a fluid. | Remember | CACE005.05 |
| 19 | Define pascal's law and Hydrostatic law and prove them? | Understand | CACE005.05 |
| 20 | Define surface tension. Prove that relationship between surface tension and pressure inside a droplet pressure is given by $p=(4\sigma/r)$ | Remember | CACE005.05 |
| **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 | CACE005.01 |
| 2 | A plate 0.0254 mm distant from a fixed plate, moves at 61 cm/sec and requires a force of 0.2 kgf/m2 to maintain this speed. Determine the dynamic viscosity of the fluid between the plates. | Remember | CACE005.01 |
| 3 | A rectangular plate of size 25 cm by 50 cm and weighing 25 kgf slides down a 300 inclined surface at a uniform velocity of 2m/sec . If the uniform 2 mm gap between the plate and the inclined surface is filled with oil determine the viscosity of the oil. | Understand | CACE005.02 |
| 4 | Calculate the capillary effect in mm in a glass tube 3 mm in diameter when immersed in (a) water (b) mercury. Both the liquids are at 200c and the values of the surface tensions for water and mercury at 200c in contact with air are respectively 0.0736 N/m and 0.51 N/m. Contact angle for water = 00 and for mercury = 1300. | Remember | CACE005.02 |
| 5 | What is the pressure within a droplet of water 0.05 mm in diameter at 200c, if the pressure outside the droplet is standard atmospheric pressure of 1.03 kg(f) / cm2. Given = 0.0075 kg(f)/m for water at 200 C. | Understand | CACE005.03 |
| 6 | If the equation of a velocity profile over a plate is V=2y2/3 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=0.075 m given H = 0.835 N.S/m2 . | Remember | CACE005.03 |
| 7 | Convert a pressure head of 100 m of water to<br>a) Kerosene of specific gravity 0.81<br>b) Carbon tetra chloride of specific gravity 1.6 | Understand | CACE005.04 |

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| 8 | A trapezoidal channel 2 m wide at the bottom and 1m deep has side slopes 1:1. Determine the total pressure and the centre pressure on the vertical gate closing the channel when it is full of water. | Understand | CACE005.04 |
| 9 | A flat plate weighing 0.45 KN has a surface area of 0.1 m2. It slides down an inclined plane at 300 to the horizontal at a constant speed of 3m/s. if the inclined plane is lubricated with an oil of viscosity 0.1Ns/m2. Find the thickness of the oil film. | Remember | CACE005.05 |
| 10 | A rectangular plane surface 3 m wide and 4 m deep lies in water in such a way that its plane making an angle of 300 with the surface of water. Determine the total pressure force and position of centre of pressure, when upper edge is 2m below the free surface. | Understand | CACE005.05 |
| **UNIT – II** | | | |
| **FLUID KINEMATICS** | | | |
| **Part – A (Short Answer Questions)** | | | |
| 1 | Define path line, stream line, stream tube and streak line. | Remember | CACE005.06 |
| 2 | State steady and unsteady flows. | Understand | CACE005.06 |
| 3 | Mention one difference between streamline and path line. | Remember | CACE005.06 |
| 4 | Define uniform and non uniform flows. | Understand | CACE005.06 |
| 5 | Give the equation of motion for free vortex flow and force vortex flow? | Remember | CACE005.06 |
| 6 | Define laminar and turbulent flows. | Understand | CACE005.06 |
| 7 | What is one dimensional flow with example? | Remember | CACE005.07 |
| 8 | Define the equation of continuity. | Understand | CACE005.07 |
| 9 | What is vorticity? | Remember | CACE005.07 |
| 10 | Define the terms vortex, free vortex flows and forced vortex flows. | Understand | CACE005.07 |
| 11 | Define rotational and ir-rotational flows. | Remember | CACE005.07 |
| 12 | What are streak lines? | Understand | CACE005.07 |
| 13 | Define compressible and incompressible flows. | Remember | CACE005.08 |
| 14 | List out two dimensional flows with example? | Understand | CACE005.08 |
| 15 | List out three dimensional flows with example? | Remember | CACE005.08 |
| 16 | Define the terms velocity potential and stream functions. | Understand | CACE005.08 |
| 17 | State Archimedes principle? | Remember | CACE005.08 |
| 18 | Give the relation between stream function and velocity potential function? | Understand | CACE005.09 |
| 19 | Define the Newton's Second law of motion. | Remember | CACE005.09 |
| 20 | What is flow net? | Understand | CACE005.09 |
| **Part - B (Long Answer Questions)** | | | |
| 1 | Sketch the flow pattern of an ideal fluid past a cylinder with circulation. | Understand | CACE005.06 |
| 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. | Remember | CACE005.06 |
| 3 | Show that in case of forced vortex flow, the rise of liquid level at the ends is equal to the fall of liquid level at the axis of rotation. | Understand | CACE005.06 |
| 4 | Obtain an expression for continuity equation for a 3-D Flow. | Remember | CACE005.06 |
| 5 | Bring out the mathematical and physical distinction between rotational and ir- rotational flows. | Understand | CACE005.06 |
| 6 | Describe the uses and limitations of flow nets. | Remember | CACE005.06 |
| 7 | Obtain an expression for continuity equation for a 1-D Flow | Understand | CACE005.07 |

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| 8 | Explain the following terms in brief:<br>a) Stream function<br>b) Velocity potential function<br>c) Circulation<br>d) Flow net | Understand | CACE005.07 |
| 9 | State the properties of stream function and prove each one of them. | Remember | CACE005.07 |
| 10 | What is a stream tube and explain are its characteristics. | Understand | CACE005.07 |
| 11 | Draw the flow pattern of a non- ideal fluid past a cylinder with rotation. | Remember | CACE005.07 |
| 12 | What is ir-rotational Flow? Show that in a Laplace equation is satisfied in potential flows-stream function and velocity potential function. | Understand | CACE005.07 |
| 13 | Distinguish between the following:<br>a) Rotational flow and ir-rotational flow<br>b) Streamlines and streak lines<br>c) Circulation and vorticity | Remember | CACE005.08 |
| 14 | What is continuity equation? Obtain the continuity equations for multi/ three dimensional flows. | Understand | CACE005.08 |
| 15 | What are the characteristics of Rotational and Ir-rotational Flows? Also distinguish with mathematical expressions. | Remember | CACE005.08 |
| 16 | Define stream function and velocity potential function. Show that the lines of constant stream function and velocity potential function must intersect orthogonally. | Understand | CACE005.08 |
| 17 | Explain continuity equation and derive the continuity equation for one dimensional flow. | Remember | CACE005.08 |
| 18 | Define Uniform and non- uniform, Compressible and non- compressible, ideal and non ideal fluids. | Understand | CACE005.09 |
| 19 | What is a streamline and a streak line. By justifying any one of the stream functions state its properties. | Remember | CACE005.09 |
| 20. | What is flow net? What are advantages and limitations of flow net analysis? | Understand | CACE005.09 |
| **Part – C (Problem Solving and Critical Thinking)** | | | |
| 1 | An open circular cylinder of 15 cm diameter and 100 cm long contains water upto a height of 70 cm. Find the speed at which the cylinder is to be rotated about its vertical axis so that the axial depth becomes zero. | Understand | CACE005.06 |
| 2 | A vessel cylindrical in shape and closed at the bottom contains water upto a height of 80 cm. The diameter of the vessel is 20 cm and length of vessel is 120 cm. the vessel is rotated at a speed of 400r.p.m about its vertical axis. Find the height of paraboloid formed. | Remember | CACE005.06 |
| 3 | In a free cylindrical vortex flows, at a point in the fluid at a radius of 200 mm and a height of 100 mm. The velocity and pressures are 10 m/s and 117.72 KN/m2.find the pressure at a radius of 400 mm and at a height of 200 mm. the fluid is air having density equal to 1.24 kg/m3. | Understand | CACE005.06 |
| 4 | The stream line function for a two dimensional flow is given by 2xy, the velocity at a point (2.0,2.0) is? The velocity of a fluid particle is given as (in meters) V= 4x2ti-5y2j+6ztk (where I,j and k are unit vectors in x,y and z directions). The resultant local acceleration at the point (2,3,2) is | Remember | CACE005.06 |

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| 5 | A vessel cylindrical in shape and closed at the bottom and the top contains water at a height of 700 mm. The dia of the vessel is 200 mm and length of the vessel is 1.1 m. Find the speed of rotation of the vessel if the axial depth of the water is Zero. | Understand | CACE005.07 |
| 6 | An open circular cylinder of 20 cm dia and 100 cm long contains water upto a height of 80 cm. It is rotated about its vertical axis. Find the speed of rotation when there is no water spills and axial depth is Zero. | Remember | CACE005.07 |
| 7 | In a free cylindrical vortex flow of water at a point at a radius of 150mm the velocity and pressure are 5 m/s and 14.715 $N/cm^2$. Find the pressure at a radius of 300 mm. | Understand | CACE005.08 |
| 8 | If the cylindrical vessel of dia 15 cm and length 100 cm contains water at a height of 80 cm is rotated at 950 r.p.m. about its vertical axis, find the Area uncovered at the base of the tank. | Remember | CACE005.08 |
| 9 | A rectangular pontoon of size 6 m length, 3 m width and 1.5 m height has a length of 0.95 m in sea water of specific weight 10055 $N/m^3$. Determine its meta centric height assuming it to have a uniform composition. | Understand | CACE005.09 |
| 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 centre of pressure | Remember | CACE005.09 |

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| **UNIT-III** | | | |
| **FLUID DYNAMICS** | | | |
| **Part - A (Short Answer Questions)** | | | |
| 1 | Name the different forces present in a fluid flow. | Understand | CACE005.10 |
| 2 | What is Euler's equation of motion. | Remember | CACE005.10 |
| 3 | Explain different types of pitot tubes. | Understand | CACE005.10 |
| 4 | Define an orifice meter. | Remember | CACE005.10 |
| 5 | What is a pitot tube. | Understand | CACE005.10 |
| 6 | Define moment of momentum equation. | Remember | CACE005.10 |
| 7 | What are the different forms of energy in a flowing fliud. | Understand | CACE005.11 |
| 8 | What is a free jet of a liquid. | Remember | CACE005.11 |
| 9 | Define continuity and Bernoulli's equation. | Understand | CACE005.11 |
| 10 | What is venturimeter. | Remember | CACE005.11 |
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| 11 | Give Energy Equation of an ideal Flow along a Streamline | Understand | CACE005.12 |
| 12 | Give the mechanical Energy equation | Remember | CACE005.12 |
| 13 | Provide Navier's equation. | Understand | CACE005.12 |
| 14 | Give the Bernoulli's equation in Irrotational flow | Remember | CACE005.12 |
| 15 | What are the types of notches? | Understand | CACE005.13 |
| 16 | Define potential head, velocity head, and datum head. | Remember | CACE005.13 |
| 17 | Give the classsificatio of orifices. | Understand | CACE005.13 |
| 18 | What are notches? | Remember | CACE005.13 |
| 19 | Give the Bernoulli's equation with head loss | Understand | CACE005.13 |
| 20 | What is a weir and what are its types? | Remember | CACE005.13 |

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| **Part – B (Long Answer Questions)** | | | |
| 1 | Define the momentum of momentum equation. What is the difference between momentum equation and impulse momentum equation | Understand | CACE005.10 |
| 2 | How do you distinguish sharp crested weir from a broad crested weir? Derive the expression for discharge over a sharp crested rectangular weir? | Remember | CACE005.10 |
| 3 | Name the different forces present in a fluid flow. For the Euler's equation of motion which forces are taken into consideration? | Understand | CACE005.10 |
| 4 | What is Euler's equation? How will you obtain Bernoulli's equation from it. | Remember | CACE005.10 |
| 5 | Discuss the relative merits and demerits of venturimeter with respect to orifice meter. | Understand | CACE005.10 |
| 6 | What is the difference between the pitot tube and pitot static tube? Derive an expression for velocity of a fluid flowing through pitot-tube? | Remember | CACE005.11 |
| 7 | What is the difference between the momentum equation and impulse momentum equation. | Understand | CACE005.11 |
| 8 | Derive Euler's equation of motion along a stream line for an ideal fluid and clearly the assumptions. | Remember | CACE005.11 |
| 9 | Derive an expression for the discharge over a rectangular notch. | Understand | CACE005.11 |
| 10 | Explain the principle of venturimeter with a neat sketch. Derive the expression rate of flow of fluid through it. | Remember | CACE005.11 |
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| 11 | State Bernoulli's theorem. Mention the assumptions made. How it is classified while applying in practice. List out engineering applications | Understand | CACE005.12 |
| 12 | Derive the expression for discharge over a broad crested weir. Differentiate broad and sharp crested weir. | Remember | CACE005.12 |
| 13 | Explain the Euler's equation of motion considering the forces | Understand | CACE005.12 |
| 14 | Find an expression for discharge over a triangular notch in terms of head of liquid over crest of the notch and the included angle. | Remember | CACE005.12 |
| 15 | State the advantages and disadvantages between venturimeter and orifice meter. | Understand | CACE005.12 |
| 16 | Show that the error in discharge due to error in the instrument of head over a rectangular notch or weir is given by (dQ/Q)=1.5(dH/H) | Remember | CACE005.13 |
| 17 | Describe with the help of sketch the construction, operation, and use of pitot- static tube. | Understand | CACE005.13 |
| 18 | What is velocity of approach? Derive the expression for discharge over a rectangular notch with the consideration of velocity of approach? | Remember | CACE005.13 |
| 19 | Derive the expression for discharge through a Cipolletti weir. | Understand | CACE005.13 |
| 20 | Derive an expression for the maximum discharge over a broad-crested weir? | Remember | CACE005.13 |
| **Part – C (Problem Solving and Critical Thinking)** | | | |
| 1 | An oil of specific gravity 0.85 is flowing steadily in a 25 cm diameter pipe at a velocity of 5 m/s. At points X and Y measurements of pressure and elevation are 250 kN/$m^2$ and 200 kN/$m^2$ and 15 m and 20 m respectively. Find the loss between two points. | Understand | CACE005.10 |
| 2 | A pipe of dia 400 mm carries water at a velocity of 25 m/s. The pressures at a point are given as 29.43 N/$cm^2$ and 22.563 N/$cm^2$ .while the datum head at A and B are 28 m and 30 m. Find the loss of head between A and B. | Remember | CACE005.10 |
| 3 | A horizontal venturimeter with inlet and throat and diameters 30 cm and 15 cm is used to measure the flow of water. The reading of differential manometer connected to the inlet and the throat is 20 cm of mercury. Determine the rate of flow. Take $C_d$ = 0.98. | Understand | CACE005.11 |

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| 4 | At a certain location X of a pipe line carrying water, the diameter is 70 cm, the pressure is 200 $kN/m^2$ and the average velocity is 6 m/s. At another section Y which is 3 m higher than X, the diameter is 40 cm and the pressure is 120 $kN/m^2$. What is the direction of flow? | Understand | CACE005.11 |
| 5 | An open cylindrical tank 16 cm diameter and 30 cm height is filled water up to the top. Find the quantity of water left in the tank, when the tank is rotated about its vertical axis with a speed of (a) 250 rpm and (b) 300 rpm. | Understand | CACE005.11 |
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| 6 | An open vertical cylinder 20 cm in diameter and 80 cm high contains 50 cm of water. If the cylinder rotates about its vertical axis, find the maximum speed that can be attained with out spilling any water? | Understand | CACE005.12 |
| 7 | A $60^0$ triangular notch with a coefficient of discharge of 0.59 is placed at the downstream end of a channel carrying $0.02m^3/s$ of water. What will be the height above the base of notch? | Remember | CACE005.12 |
| 8 | A rectangular notch of width 0.5 m and coefficient of discharge 0.62 is placed at the downstream end of a channel carrying 0.04 $m^3/s$ of water. An error of 2.5 mm was made in measuring the head over the notch. Find the percentage error in the discharge. | Understand | CACE005.12 |
| 9 | In a 100mm dia 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 | CACE005.13 |
| 10 | A rectangular notch of width 1.4 m is fitted in the side of a tank of area 8 $m^2$. Find the time required to lower the water level from 8 m to 3 m. The coefficient of discharge is 0.2 | Understand | CACE005.13 |
| **UNIT-IV** | | | |
| **BOUNDARY LAYER THEORY** | | | |
| **Part – A (Short Answer Questions)** | | | |
| 1 | What do you understand by the term boundary layer thickness? | Understand | CACE005.14 |
| 2 | What is meant by boundary layer? | Remember | CACE005.14 |
| 3 | What do you mean by boundary layer separation? | Understand | CACE005.14 |
| 4 | Define displacement thickness. | Remember | CACE005.14 |
| 5 | What are the different methods of preventing the separating of Boundary layers. | Understand | CACE005.15 |
| 6 | What is the effect of pressure gradient on boundary layer separation? | Remember | CACE005.15 |
| 7 | Define laminar boundary layer and turbulent boundary layer. | Understand | CACE005.15 |
| 8 | Draw Boundary layer and Free Stream for Flow Over a flat plate | Remember | CACE005.15 |
| 9 | Distinguish lift and drag. | Understand | CACE005.15 |
| 10 | Define magnus effect. | Remember | CACE005.15 |
| 11 | Write the prandtl contribution in boundary layer theory. | Understand | CACE005.16 |
| 12 | Define laminar sub layer and boundary layer thickness. | Remember | CACE005.16 |
| 13 | Write two applications of boundary layer theory | Understand | CACE005.16 |
| 14 | Give an expression for the turbulent boundary layer on a flat plate? | Remember | CACE005.16 |
| 15 | Write Von karman momentum integral transition equation? | Understand | CACE005.17 |
| 16 | What is Boundary layer Transition? | Remember | CACE005.17 |
| 17 | Give the condition for Boundary layer Separation. | Understand | CACE005.17 |
| 18 | Enumerate Boundary layer control. | Remember | CACE005.18 |

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| 19 | State the term drag and lift? | Understand | CACE005.18 |
| 20 | Define the term momentum thickness. | Remember | CACE005.18 |
| | **Part – B (Long Answer Questions)** | | |
| 1 | Derive an expression for displacement thickness due to formation of boundary layer | Understand | CACE005.14 |
| 2 | Explain with sketches the three methods of boundary layer control. | Remember | CACE005.14 |
| 3 | Derive an expression for momentum thickness of boundary layer. | Understand | CACE005.14 |
| 4 | The velocity distribution in the turbulent boundary layer over a flat plate is given as $(u/U_\infty) = 2(y/\delta)-(y/\delta)^2$ Obtain the expression for displacement thickness and momentum thickness? | Remember | CACE005.14 |
| 5 | Derive the expression for the energy and momentum correction factor? | Understand | CACE005.15 |
| 6 | Derive an expression for energy thickness of boundary layer. | Remember | CACE005.15 |
| 7 | Obtain Von karman momentum integral equation? | Understand | CACE005.15 |
| 8 | Explain boundary layer separation? Mention few methods to prevent or delay the separation of boundary layer? | Remember | CACE005.15 |
| 9 | Derive Prandtl's boundary layer equation. | Understand | CACE005.15 |
| 10 | The velocity profile within boundary layer for steady, two-dimensional, constant density, laminar flow ovr a flat plate is given as $U = A+By+Cy^2$ Using suitable boundary conditions, find the form of the velocity profile. | Remember | CACE005.15 |
| 11 | Explain the formation of boundary layer and displacement thickness. | Understand | CACE005.16 |
| 12 | What is boundary layer control and explain with diagrams. | Remember | CACE005.16 |
| 13 | What is momentum thickness? Explain its characteristics. | Understand | CACE005.16 |
| 14 | The velocity distribution in the turbulent boundary layer over a flat plate is given as $(u/U_\infty) = 2(y/\delta)-(y/\delta)^2$ Obtain the expression for energy thickness and momentum thickness? | Remember | CACE005.16 |
| 15 | Explain Boundary layer in separation, Transition and control. | Understand | CACE005.17 |
| 16 | Show that the following velocity profile in hydrodynamic boundary layer satisfies the requisite boundary conditions for fluid flow over a flat plate $(u/U_\infty) = \sin(\pi y/2\delta)$ | Remember | CACE005.17 |
| 17 | Derive expressions for boundary layer thickness ,boundary shear stress and friction drag in a laminar boundary layer | Understand | CACE005.17 |
| 18 | The velocity distribution in the turbulent boundary layer over a flat plate is given as $(u/U_\infty) = (y/\delta)^{(1/5)}$. Obtain the expression for the displacement thickness and momentum thickness. | Remember | CACE005.18 |
| 19 | Explain how laminar and turbulent boundary layers are formed and distinguish between their characteristics. | Understand | CACE005.18 |
| 20 | Explain the characteristics of a boundary layer of a thin flat plate. | Remember | CACE005.18 |
| | **Part – C (Problem Solving and Critical Thinking)** | | |
| 1 | A plate of 800 mm length and 500 mm wide is immersed in a fluid of specificgravity 0.92 and kinematic viscosity $v=10^{-4}$ $m^2/s$. The fluid is moving with a velocity of 8 m/s. Determines boundary layer thickness, shear stress at the end of the plate and drags force one side of the plate. | Understand | CACE005.14 |

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| 2 | Air flows at 10 m/s past a smooth rectangular flat plate 0.3 m wide and 3 m long. Assuming that's the turbulence level in the oncoming stream is low and that transition occurs at $R_e$=5000. 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. | Remember | CACE005.14 |
| 3 | Oil with a free stream velocity of 2 m/s flows over a thin plate 2 m wide and 2 m 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 $10^{-3}$ $m^3/s$. | Understand | CACE005.14 |
| 4 | A thin plate is moving in still atmospheric air at a velocity of 4 m/s. The length of plate is 0.5 m and width is 0.4 m, 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 1.25 $kg/m^3$ and kinematic viscosity 0.15 stokes. | Remember | CACE005.15 |
| 5 | 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 | CACE005.15 |
| 6 | 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 Kmph and power required to overcome this drag. Dynamic viscosity of air = 0.000185 poise and specific weight = 12 $N/m^3$. | Remember | CACE005.16 |
| 7 | A smooth flat plate of size 6 m by 3 m is towed in a liquid of density 900 kg/ $m^3$ 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 | CACE005.16 |
| 8 | A plate of 600 mm length and 400 mm 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. determines boundary layer thickness, shear stress at the end of the plate and drag force one side of the plate. | Remember | CACE005.17 |
| 9 | Air flows at 10 m/s past a smooth rectangular flat plate 0.3 m wide and 3m long. Assuming that's the turbulence level in the oncoming stream is low and that transition occurs at $R_e$=5 X $10^5$, 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 | CACE005.18 |
| 10 | Oil with a free stream velocity of 2 m/s flows over a thin plate 2m wide and 2 m 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 0.0001 $m^2/s$ | Remember | CACE005.18 |
| UNIT-V | | | |
| **Closed Conduit Flow** | | | |
| **Part - A (Short Answer Questions)** | | | |
| 1 | Define Reynold's experiment. | Understand | CACE005.19 |
| 2 | What are the characteristics of laminar flows? | Remember | CACE005.19 |
| 3 | Draw the figure for shear stress and velocity profile in a pipe for laminar flow. | Understand | CACE005.19 |
| 4 | Give an expression for the loss of head due to sudden expansion and sudden contraction of pipe. | Remember | CACE005.19 |
| 5 | What are the laws of fluid friction? | Understand | CACE005.20 |

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| 6 | Define Darcy's equation. | Remember | CACE005.20 |
| 7 | Give Expression for loss of energy due to friction. | Understand | CACE005.20 |
| 8 | What are minor losses in pipes in parallel? | Remember | CACE005.20 |
| 9 | What is total energy line? | Understand | CACE005.21 |
| 10 | What is hydraulic gradient line? | Remember | CACE005.21 |
| 11 | What are minor losses in pipes in series? | Understand | CACE005.21 |
| 12 | What is the loss of head at the entrance of a pipe? | Remember | CACE005.21 |
| 13 | What is hydraulic gradient line? | Understand | CACE005.21 |
| 14 | What are the characteristics of turbulent flows? | Remember | CACE005.22 |
| 15 | Draw the figure for shear stress and velocity profile in a pipe for turbulent flow. | Understand | CACE005.22 |
| 16 | What is Moody's chart? | Remember | CACE005.23 |
| 17 | Draw the figure for fully developed turbulent pipe flow. | Understand | CACE005.23 |
| 18 | State the characteristics of turbulent flow. | Remember | CACE005.23 |
| 19 | Compare velocity profiles in laminar and turbulent flows. | Understand | CACE005.24 |
| 20 | What is Water hammer effect? | Remember | CACE005.24 |
| **Part - B (Long Answer Questions)** | | | |
| 1 | What is meant by equivalent pipe? Determine the equivalent pipe corresponding to 3 pipes in series? | Remember | CACE005.19 |
| 2 | Derive formulas for hydraulic gradient and total energy lines | Understand | CACE005.19 |
| 3 | Derive the equation for head loss in pipes due to friction Darcy-Weisbach equation. | Remember | CACE005.19 |
| 4 | What are the minor losses in pipes? Give the appropriate formulae to calculate the losses. | Understand | CACE005.19 |
| 5 | What do you understand by turbulent flow? What factor decides the type of flow in pipes? | Remember | CACE005.20 |
| 6 | Derive an expression for the loss of head due to sudden enlargement in pipes. | Understand | CACE005.20 |
| 7 | Show that the energy transmitted by a long pipe is maximum when 1/3 rd of energy put into the pipe is lost in friction. | Remember | CACE005.20 |
| 8 | Explain the phenomenon of water hammer pressure. Obtain an expression for the rise of pressure when the flowing water in a pipe is brought to rest by closing the valve gradually. | Understand | CACE005.20 |
| 9 | Derive the equivalent size of the pipes when 'n' no of pipes connected in a) parallel. b) series | Remember | CACE005.21 |
| 10 | Explain what you understand by hydraulic grade line and total energy line. Discuss its practical significance in analysis of fluid flow problems. | Understand | CACE005.21 |
| 11 | Explain the phenomenon of transmission of power through pipeline and the condition for maximum efficiency. | Remember | CACE005.21 |
| 12 | Obtain the expressions for Hydraulic gradient line and total energy lines. | Understand | CACE005.21 |
| 13 | Derive the equations for head loss in pipes using Darcy-Weisbach equation. | Remember | CACE005.21 |
| 14 | Explain minor and major losses in pipes and list out the expressions with neat sketches. | Understand | CACE005.22 |
| 15 | List out the important factors determining the type of flow in pipes. | Remember | CACE005.22 |
| 16 | Explain the phenomenon of velocity defect in pipes. | Understand | CACE005.23 |

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| 17 | Explain the phenomenon of Water Hammer. Obtain an expression for the rise of pressure when the flowing water in a pipe is brought to rest by closing the valve gradually. | Remember | CACE005.23 |
| 18 | Elaborate the practical significance in analysis of fluid flow problems. Distinguish Hydraulic gradient line and total energy line. | Understand | CACE005.23 |
| 19 | Find an expression for the ratio of the ratio of the outlet area of the nozzle to the area of the pipe for maximum transmission power. | Remember | CACE005.24 |
| 20 | Explain the characteristics of laminar and turbulent flow and flow between parallel plates with neat sketches. | Understand | CACE005.24 |
| **Part – C (Problem Solving and Critical Thinking)** | | | |
| 1 | A pipe line of length 2100 m is used for transmitting 103 KW. The pressure at inlet of the pipe is 392.4 $N/cm^2$. If the efficiency of transmission is 80%, find the diameter of pipe. Take *f= 0.005* | Understand | CACE005.19 |
| 2 | A smooth pipe of diameter 400 mm and length 800 mm carries water at the rate of 0.04 $m^3$ /s. determine the head lost due to friction, wall shear stress, centre line velocity and thickness of laminar sub layer. Take kinematic viscosity of water as 0.018 stokes. | Remember | CACE005.19 |
| 3 | Water is flowing through a rough pipe of diameter 600 mm at the rate 600 liters/sec. the wall roughness is 3 mm. find the power lost for 1 km length of pipe. | Understand | CACE005.19 |
| 4 | A 0.3 m diameter pipe 2340 m long is connected with a reservoir whose surface is 72 m above the discharging end of the pipe. If for the last 1170 m, a second pipe of the same diameter be laid beside the first and connected to it. What would be the increase in the discharge? Take f=0.02 | Remember | CACE005.20 |
| 5 | A compound piping system consists of 1800 m of 0.50 m, 1200 m of 0.40 m and 600 m of 0.30 m new cast iron pipes connected in series. Convert the system to<br>(a) an equivalent length of 0.40 m pipe and<br>(b) Equivalent size pipe 3600 m long. | Understand | CACE005.20 |
| 6 | A pipe having a length of 6 km and diameter 0.70 m connects two reservoirs A and B, the difference between their water levels is 30 m. Half way along the pipe there is a branch through which water can be supplied to a third reservoir C. Taking f = 0.024 determine the rate of flow of reservoir B when<br>a) no water is discharged to reservoir C<br>b) the quantity of water discharged to reservoir C is 0.15 $m^3$/s neglect minor losses. | Remember | CACE005.21 |
| 7 | A pipeline 0.225 m in diameter and 1580 m long has a slope of 1 in 200 for the first 790 m and 1 in 100 for the next 790 m. The pressure at the upper end of the pipeline is 107.91 kpa and at the lower end is 53.955 kpa. Taking f=0.032 determine the discharge through the pipe. | Understand | CACE005.22 |
| 8 | The velocities of water through a pipe of diameter 10 cm are 4 m/s and 3.5 m/s at the centre of the pipe and 2 cm from the pipe centre respectively. Determine the wall shearing stress in the pipe for turbulent flow. | Remember | CACE005.23 |
| 9 | Determine the average height of the roughness for a rough pipe of diameter 10 cm when the velocity at a point 4 cm from wall is 40% more than the velocity at a point 1 cm from pipe wall. | Understand | CACE005.23 |
| 10 | For turbulent flow in a pipe diameter 300 mm, find the discharge when the centre line velocity is 2 m/s and the velocity at a point 100 mm from the centre as measured by pitot tube is 1.6 m/s. | Remember | CACE005.24 |

**Prepared by**
Dr G V Ramana, Professor & HOD

**HOD, CIVILENGINEERING**