Roll No: --------------------------

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: M.TECH CFD | **Semester – I**
Subject (Course):Introduction to Fluid Dynamics | **Max. Marks : 100**
Course Code :ASEG 7002 | **Duration : 3 Hrs**
No. of page/s:03

Section A: Answer all the question given below (4 x 5 = 20 Marks)

1. What is the Eulerain and Lagrangian description of fluid motion, A tiny neutrally buoyant electronic pressure probe is released into the inlet pipe of a water pump and transmits 2000 pressure readings per second as it passes through the pump. Is this a Lagrangian or an Eulerian Measurement, Explain.
2. Describe body, forces, and surface forces, and explain how the net forces acting on a control volume is determined. If fluid, weight a body force or surface forces, How about pressure?
3. Discuss why fluid density has negligible influence on the aerodynamics drag on a particle moving in the creeping flow.
4. For incompressible fluids the volumetric dilation rate must be zero, that is, $\nabla \cdot V = 0$ for what combination of constants a,b,c and e can the velocity components

$$u = ax + by$$
$$v = cx + ey$$
$$w = 0$$

be used to describe an incompressible flow field

Section B: Answer the following Questions given below (4×10=40 Marks)

5. Consider steady, incompressible, parallel, laminar flow of a film of oil falling slowly down an infinite vertical wall. The oil film thickness is h, and gravity acts in the negative z-direction. There is no applied pressure driving the flow- The by gravity alone. Calculate the

velocity and pressure field in the oil film and sketch the normalized velocity profile. You may neglect changes in the hydrostatic pressure of the surrounding air?

6. A steady incompressible flow, moving through a contraction section of length L, has a one-dimensional average velocity distribution given by $u=U_0(1+2x/L)$. What is its convective acceleration at the end of the contraction, x=L.

7. Water flows at a rate of 70 L/min through a flanged faucet with a partially closed gate valve spigot. The inner diameter of the pipe at the location of the flange is 2 cm, and the pressure at that location is measured to be 90 kPa. The total weight of the faucet assembly plus the water within it is 57 N. Calculate the net force on the flange?

8. Water enters a tank of diameter D_T steadily at a mass flow rate of m. Am orifice at the bottom with diameter D_0 allows water to escape. The orifice has a rounded entrance, so the frictional losses are negligible. If the tank is initially empty,

(a). Determine the maximum height that the water will reach in the tank and

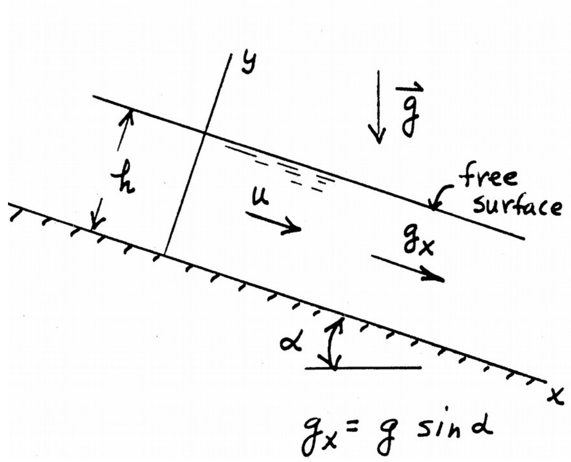
(b). obtain a relation for water height z as a function of time

Section C: Answer All the following Questions given below (2×20=40 Marks)

9. (a). A fluid rotation as a rigid body around z axis. The steady incompressible velocity field is given by $u_r=0$, $u_\theta=\omega r$, and $u_z=0$. The pressure at the origin is equal to P_0. Calculate the pressure filed everywhere in the flow, and determine the Bernoulli constant along each streamline? (10 Marks)

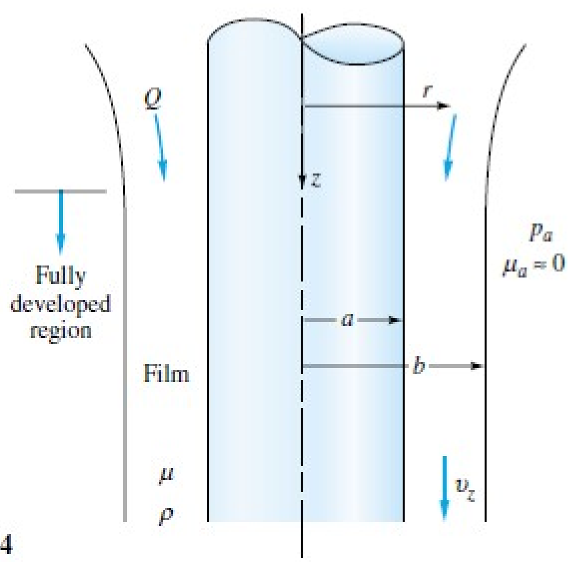
(b). Derive the Bernoulli equation in Inviscid Region of flow using velocity Identity, also express the Euler's equations for a region of flow (10 Marks)

10. A layer of viscous liquid of constant thickness flows steadily down an infinite, inclined plane. Determine, by the means of N-S equations, the relationship between the thickness of the layer and the discharge per unit width. The flow is laminar, and assumes air resistance is neglected. So that the shearing stress at the free surface is zero.



(OR)

11. Consider a Viscous Film of liquid draining uniformly down the side of a vertical rod of radius a, as shown in the figure. At some distance down the rod the film will approach a terminal or fully developed draining flow of constant outer radius b, with v_z=v_z(r), v_θ = v_r =0. Assume that the atmosphere offers no shear resistance to the film motion. Derive a differential equation for v_z, state the proper boundary conditions, and solve for the film velocity distribution. How does the film radius b relate to the total film volume flow rate Q?



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Section A: Answer all the question given below (4 x 5 = 20 Marks)

1. Is the Eulerian method of fluid flow analysis more similar to study of a system or a control volume? Explain. Define a steady flow field in the Eulerian reference frame. In such a steady flow, is it possible for a fluid particle to experience a non zero acceleration?
2. How do surface forces arise in the momentum analysis of control volume? How can we minimize the number of surface forces exposed during analysis?
3. What is the most important criterion for use of the modified pressure p' rather than the thermodynamic pressure P in a solution of the Navier-Stokes equations?
4. Continuum hypothesis suffers in rarefied gas flows and gas flows in micro and Nano geometries explain the reasons for it, also mention the scope of continuum Hypothesis?

Section B: Answer All the following Questions given below (4×10=40 Marks)

5. Consider Steady two dimensional flow field in the xy-plane whose x-component of velocity is given by

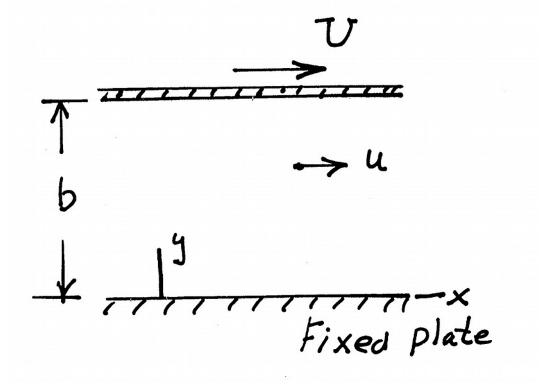
$$u=a+b(x-c)^2$$

Where a,b,c are constants with appropriate dimensions of what form does the y component of velocity need to be in order for the flow field to be incompressible? In other words, generate an expression for v as a function of x,y and the constants of the given equation such that the flow is incompressible?

6. A garden hose attached with a nozzle is used to fill a 10 gal bucket. The inner diameter of the hose is 2 cm, and it reduces to 0.8 cm at the nozzle exit. If it takes 50 s to fill the bucket with water, determine
   a. The volume and mass flow rate of water through the hose
   b. The average velocity of water at the nozzle
7. A stream of incompressible liquid moving at low speed leaves a nozzle pointed directly downward. Assume the speed at any cross section is uniform and neglect viscous effects. The speed and area of the jet at the nozzle exit are V_0 and A_0, respectively. Apply conservation of mass and the momentum equation to a differential control volume of length dz in the flow direction. Derive expressions for the variations of jet speed and area as functions of z. Evaluate the distance at which the jet area is half its original value. (Take the origin of coordinates at the nozzle exit).
8. The velocity potential for a certain inviscid flow field
   $\phi = -(3x^2y - y^3)$
   Where ϕ has the units of ft^2/s when x and y are in feet. Determine the pressure difference between the points (1,2) and (4,4), where coordinates are in feet, if the fluid is water and elevation changes are negligible.

Section C: Answer the following Questions given below (2×20=40 Marks)

9. Derive General form of 3D Navier-Stoke equations and explain the limitations in solving fluid problems?
10. Two Horizontal, Infinite, Parallel plates are spaced a distance b apart. A viscous liquid is contained between the plates. The bottom plate is fixed and the upper plate moves parallel to the bottom plate with a velocity U. Because of the no-slip boundary condition, the liquid motion is caused by the liquid being dragged along by the moving boundary. There is no pressure gradient in the direction of flow. Note that this is a so-called simple Couette flow. (a). Start with the Navier-Stokes equations and determine the velocity distribution between the plates. (b). Determine an expression for the flow rate passing between the plates for a unit width. Express your answer in terms of b and U.



(OR)

11. The viscosity oil is set into steady motion by a concentric inner cylinder moving axially at velocity U inside a fixed outer cylinder. Assuming constant pressure and density and a purely axial fluid motion. Solve for the fluid velocity distribution $v_z(r)$. What are the proper boundary conditions?