Concordia University

Department of Mechanical & Industrial Engineering
MECH361/2T (Fluid Mechanics-II)
Mid-Term Examination, Fall 2008

Full Marks-100 Time: ONE hour 15 minutes

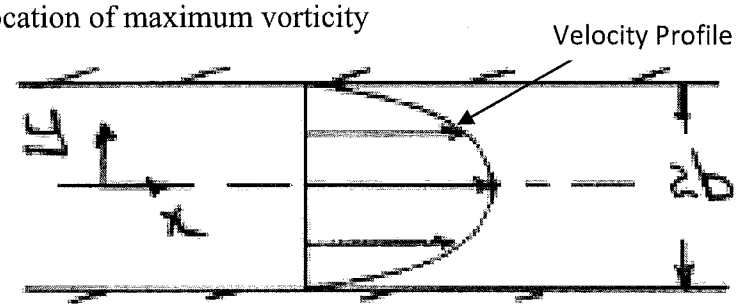
Special Instructions:

(i) Write your answers very specific, neat and clean.
(ii) In solving problems, show the calculations in details.
(iii) For dimensional quantities, write correct units; otherwise negative credit will be awarded.
(iv) The symbols bear their usual meaning.

(3 pts) 1. Why do we use **differential form** rather than **integral form** of Governing equations in Fluid Dynamics?

(10 pts) 2. Velocity field for a steady state laminar flow of a fluid between two fixed horizontal plates is given by $u = u_{max}\left[1 - \left(\frac{y}{b}\right)^2\right]$. Find

(a) Rates of linear and angular deformation
(b) Expression for the vorticity vector, ζ
(c) Location of maximum vorticity



(15 pts) 3. A vortex pair is formed by a clockwise vortex of strength K located at (-a, 0) and a counter- clockwise vortex of strength K located at (a, 0). Find (i) Expressions for ψ , ϕ and velocity field and (ii) Pressure distribution along the y-axis.

(15 pts) 5. The velocity components of a plane (Two dimensional) incompressible fluid flow are given by $v_r = \left(1 - \frac{A}{r^2}\right)cos\theta$ and $v_\theta = -\left(1 + \frac{A}{r^2}\right)sin\theta - \frac{B}{r}$.

(a) Is this a physically possible fluid flow field?
(b) If the flow field is a possible one, then find vorticity and hence determine whether the flow is rotational or NOT.

(15 pts) 6. Distinguish between

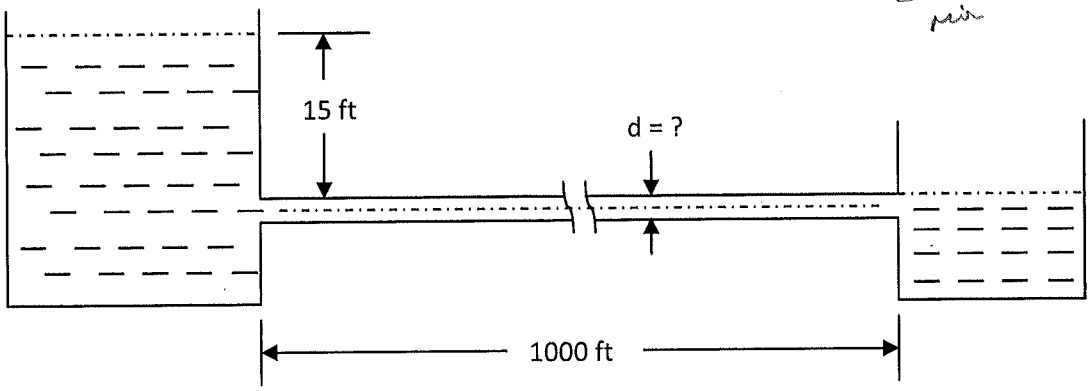
(a) Ideal fluid and real fluid
(b) Compressible fluid and compressible flow
(c) Steady flow and uniform flow
(d) Wall shear stress and viscous shear stress
(e) No-slip boundary condition and no-penetration boundary condition

(10 pts) 7. For steady laminar flow between two fixed infinite horizontal parallel plates (Plane Poiseuille flow), find the location where $u\ (y) = v_{avg}$ and show this location on a schematic sketch of velocity distribution.

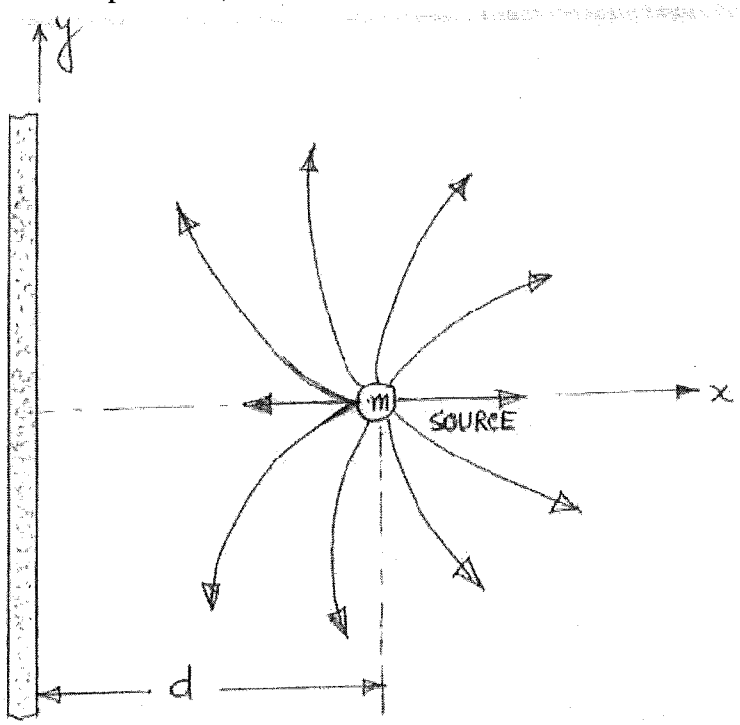
1 cfs = 448 gpm

(15 pts) 8. Two oil reservoirs with difference in elevation of 15 feet are connected by a 1000 feet long commercial steel pipe. What size must the pipe be to convey 1000 gpm? Consider all losses. For square edge, $k_{in} = 0.5$.

gallon / min



(12 pts) 9. A source of strength ***m*** is located at a distance ***d*** from a vertical solid wall as shown in figure. The flow is incompressible, irrotational and inviscid. The velocity potential for this



flow is given by, $\phi = \frac{m}{4\pi}\{ln[(x-d)^2 + y^2] + ln[(x+d)^2 + y^2]\}$

(a) Show that there is no flow through the wall.
(b) Determine the expression for the velocity along the vertical wall.

(5 pts.) 10. Write the physical significance of Reynold's number (Re) and Mach Number (Ma).