(18%) 1. Explain following terms :

(a) Continuum

(b) Newtonian fluid

(c) Inviscid fluids, Ideal fluid

(d) The condition of no slip of viscosity at solid boundary

(e) Streamline, Pathline, Streakline

(f) Static pressure, stagnation pressure, and dynamic pressure

(12%) 2. The specific gravity of the manometer fluid shown in Fig. 1 is 1.07. Determine the volume flowrate, Q, if the flow is inviscid and incompressible and the flowing fluid is (a) water, (b) gasoline, or (c) air at standard conditions. (γ : specific gravity, $\gamma_{water} = 9.8\ KN/m^3$, $\gamma_{gasoline} = 6.67\ KN/m^3$, $\gamma_{air} = 12 \times 10^{-3}\ KN/m^3$)

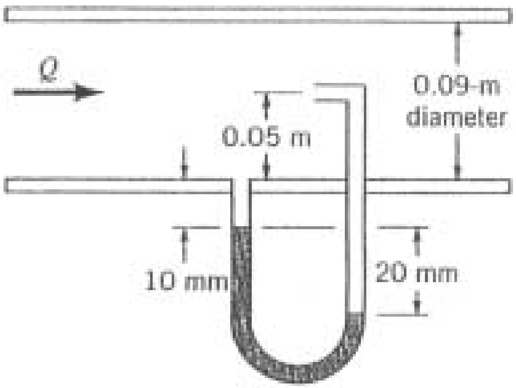

FIGURE 1

(20%) 3. Water enters a rotating lawn sprinkler through its base at the steady rate of 16 gal/min as shown in Fig. 2. The exit cross-sectional area of each of the two nozzles is 0.04 $in.^2$, and the flow leaving each nozzle is tangential. The radius from the axis of rotation to the centerline of each nozzle is 8 in. (a) Determine the resisting torque required to hold the sprinkler head stationary. (b) Determine the resisting torque associated with the sprinkler rotating with a constant speed of 500 rev/min. (c)Determine the angular velocity of the sprinkler if no resisting torque is applied.

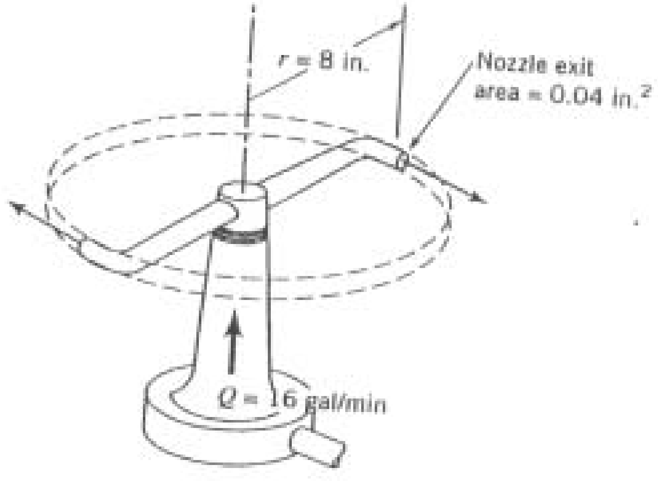

FIGURE 2

(28%) 4. (a) Employ dimensional analysis to study the unsteady motion $u(y,t)$ due to an infinite plate, in an infinite fluid, initially at rest and then suddenly given a constant velocity U in the direction parallel to plate (i.e., x-direction). Find the proper form of the functional relationship between $u(y,t)$ and the other flow parameters: U (constant plate velocity), y (coordinate perpendicular to plate), t (time), and ν (kinematic viscosity). **(b)** If the dependent variable was $u(y,t)/U$, find the proper form of the functional relationship between $u(y,t)/U$ and the other flow parameters: y, t, ν. **(c)** Discuss the difference between the two formulations.
(d) Write down the Navier-Stokes equation, continuity equation, initial and boundary conditions of this problem.

(10%) 5. Derive the Prandtl's boundary layer equations for the 2-D laminar boundary layer flow over a horizontal plate.

(12%) 6. Discuss the difference between the governing equations for turbulent flow and laminar flow and its consequence.