مکانیک سیالات ۲

تمرینات سری دوم — زمان تحویل: ۳ آبان ۹۳

1. Find the resultant velocity vector induced at point A in Fig. 1 by the uniform stream, vortex,and line source.

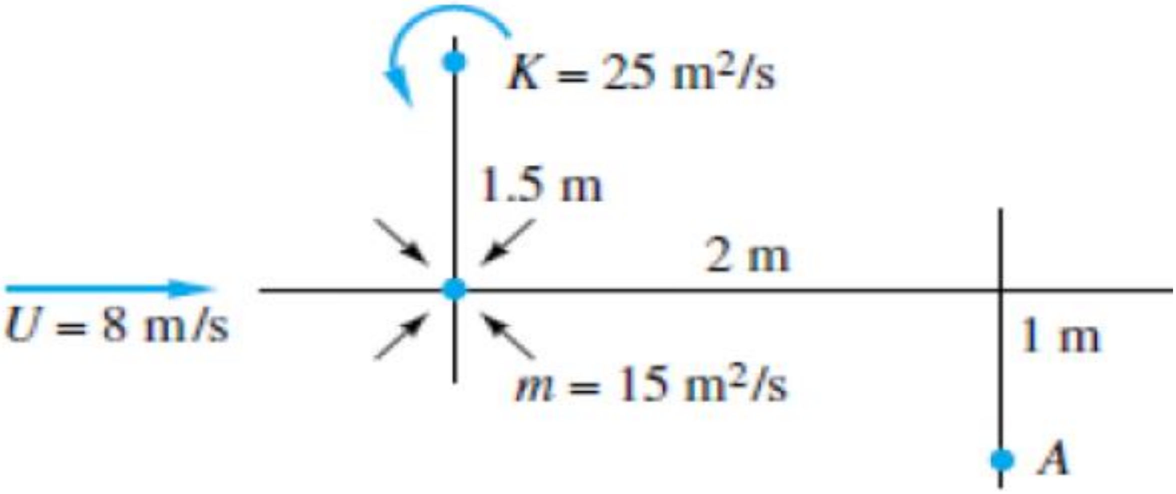

Fig. 1

2. A Rankine half-body is formed as shown in Fig. 2. For the stream velocity and body dimension shown, compute (*a*) the source strength *m* in m$_2$/s, (*b*) the distance *a*, (*c*) the distance *h*, and (*d*) the total velocity at point *A*.

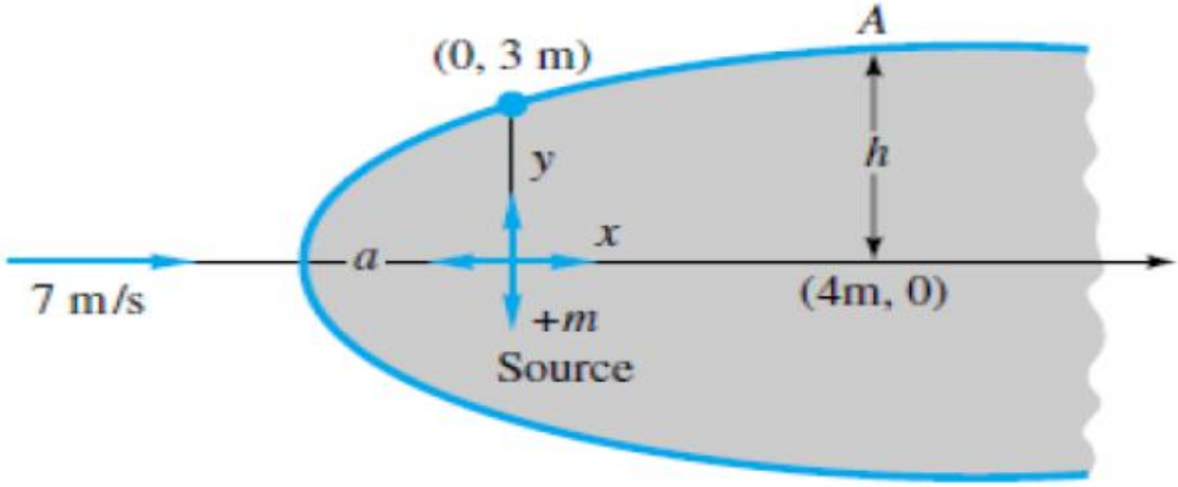

Fig. 2

3. Wind at U_∞ and p_∞ flows past a Quonset hut which is a half-cylinder of radius *a* and length *L* (Fig. 3). The internal pressure is p_i. Using inviscid theory, derive an expression for the upward force on the hut due to the difference between p_i and p_s.

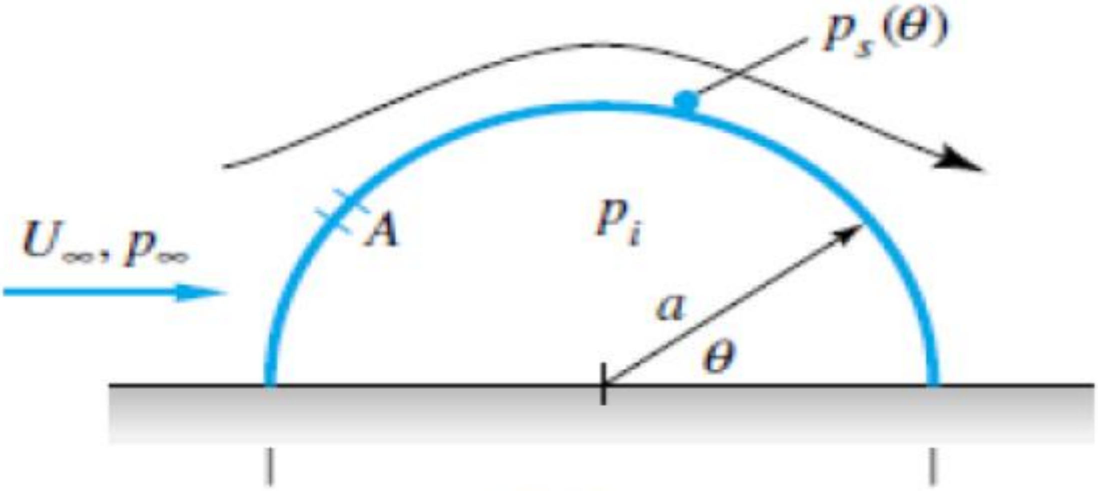

Fig. 3

4. It is desired to simulate flow past a two-dimensional ridge or bump by using a streamline which passes above the flow over a cylinder, as in Fig. 4. The bump is to be $a/2$ high, where a is the cylinder radius. What is the elevation h of this streamline? What is U_{max} on the bump compared with stream velocity U?

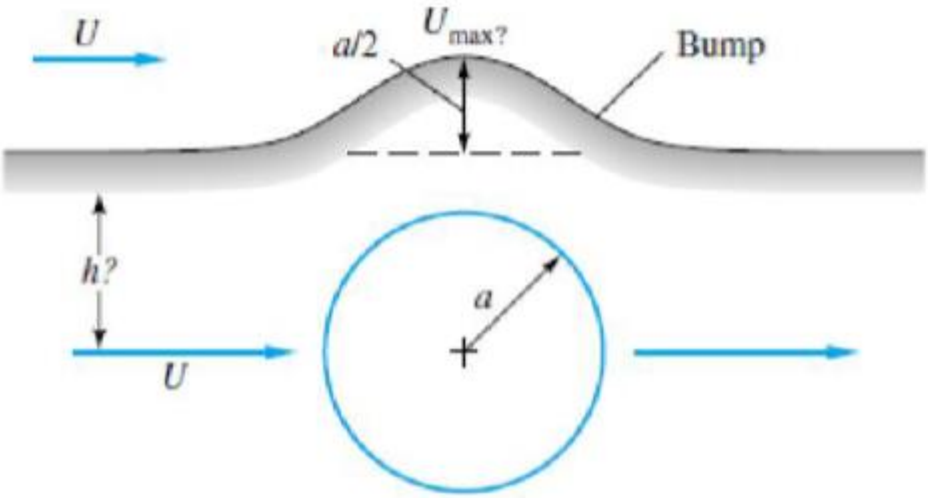

Fig. 4

5. The steady plane flow in Fig. 5 has the polar velocity components $v_\theta = \Omega r$ and $v_r = 0$. Determine the circulation Γ around the path shown.

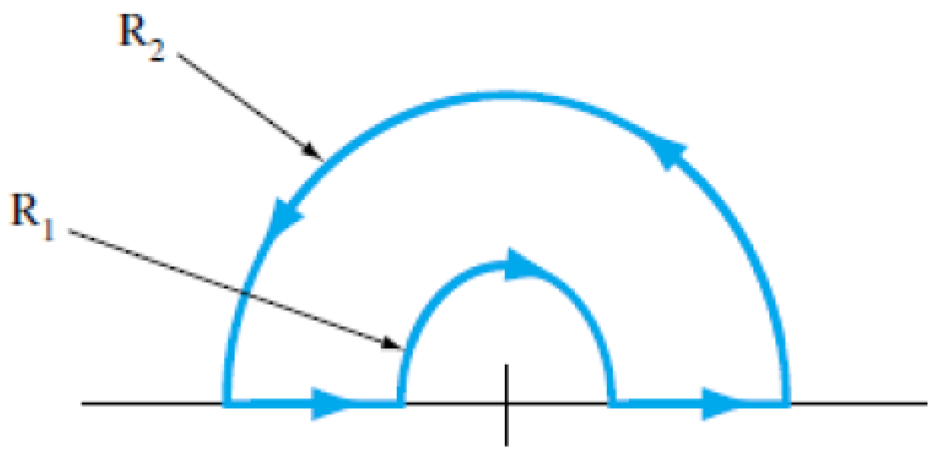

Fig. 5

6. The velocity potential for a spiral vortex flow is given by $\phi = (\Gamma/2\Pi)\theta - (m/2\Pi) \ln r$, where Γ and m are constants. Show that the angle, α, between the velocity vector and the radial direction is constant throughout the flow field (see Fig. 6)

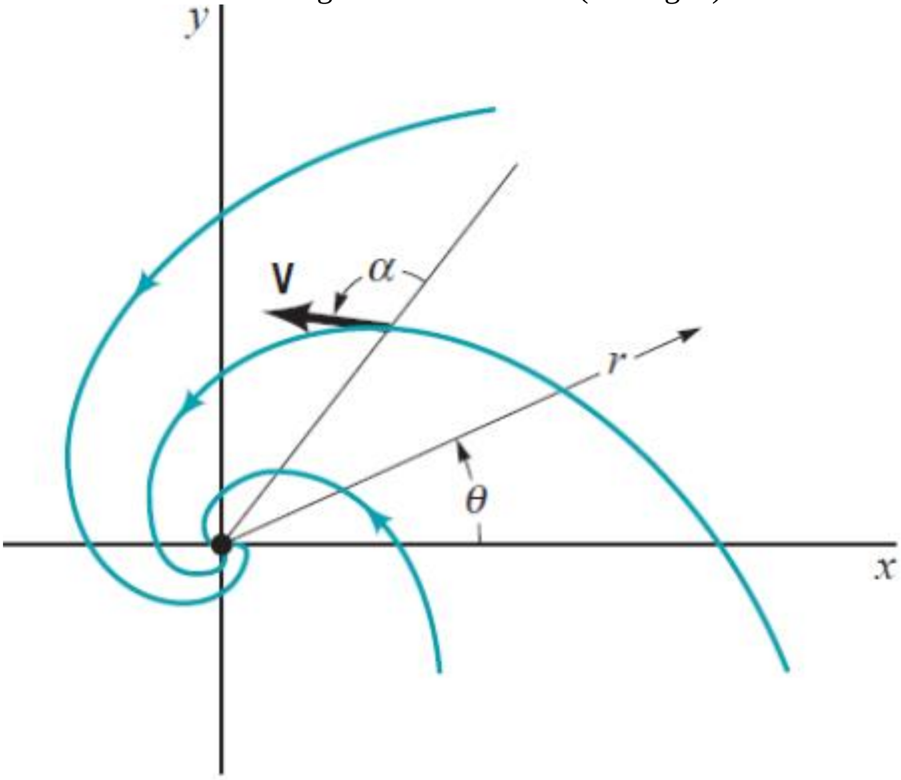

Fig. 6

7. Assume that the velocity distribution in the vortex (see Fig. 7) is the same as that for a free vortex. At the same time the water is being discharged from the tank at point *A*, it is desired to discharge a small quantity of water through the pipe *B*. As the discharge through *A* is increased, the strength of the vortex, as indicated by its circulation, is increased. Determine the maximum strength that the vortex can have in order that no air is sucked in at *B*. Express your answer in terms of the circulation. Assume that the fluid level in the tank at a large distance from the opening at *A* remains constant and viscous effects are negligible.

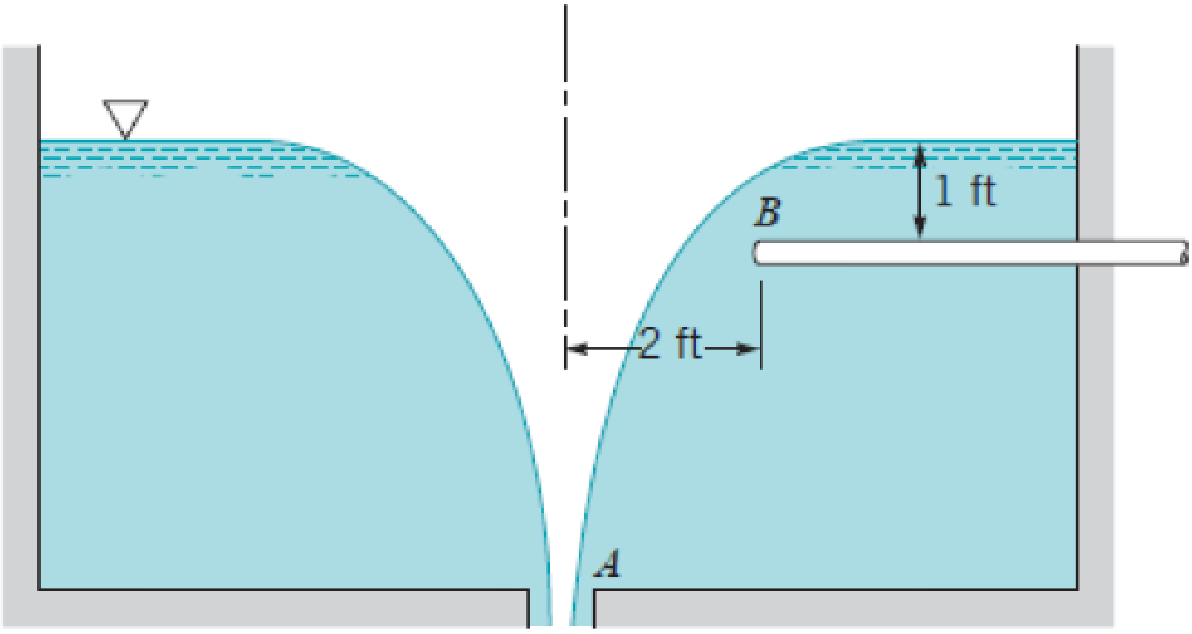

Fig. 7

8. A two-dimensional, incompressible, frictionless fluid is guided by wedge-shaped walls into a small slot at the origin, as in Fig. 8. The width into the paper is b, and the volume flow rate is Q. At any given distance r from the slot, the flow is radial inward, with constant velocity. Find an expression for the polar-coordinate stream function of this flow.

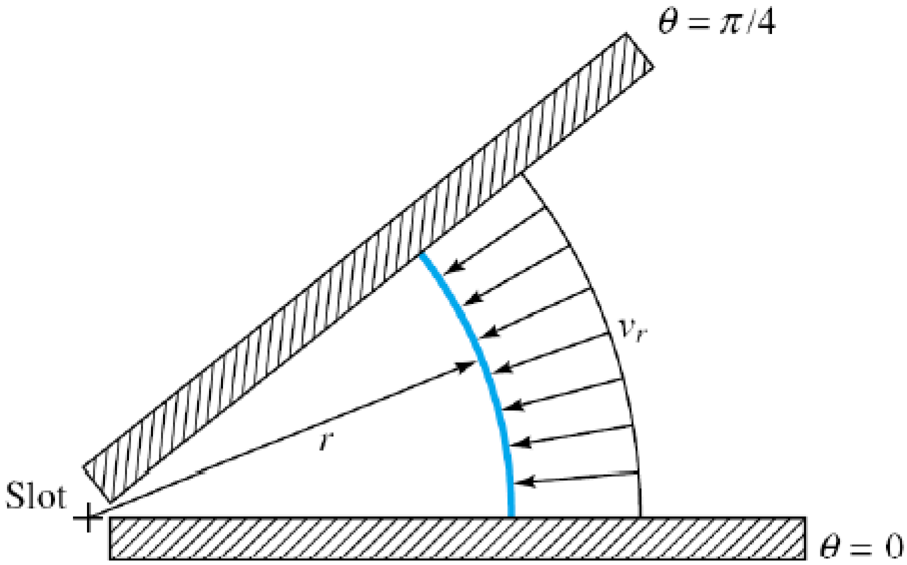

Fig. 8