ME 326: Intermediate Fluid Mechanics, HW # 7

1.

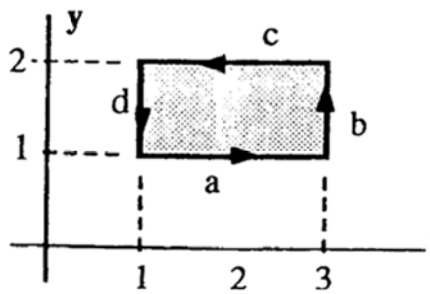
Is the function ***1/r*** a legitimate velocity potential in plane polar coordinates? If so, what is the associated stream function $\psi(r,\theta)$?

2.

Consider the two-dimensional velocity distribution $u = -By$, $v = +Bx$, where B is a constant. If this flow possesses a stream function, find its form. If it ha: a velocity potential, find that also. Compute the local angular velocity of the flow, if any, and describe what the flow might represent.

3.

8.8 For the velocity distribution of Prob. 8.5, $u = -By$, $v = +Bx$, evaluate the circulation Γ around the rectangular closed curve defined by (x,y) = (1.1), (3,1), (3,2), and (1,2).



4.

A tornado may be modeled as the circulating flow shown in Fig. P8.14, with $v_r = v_z = 0$ and $v_\theta(r)$ such that

$$v_\theta = \begin{cases} \omega r & r \le R \\ \dfrac{\omega R^2}{r} & r > R \end{cases}$$

Determine whether this flow pattern is irrotational in either the inner or outer region. Using the *r*-momentum equation (D.5) of App. D, determine the pressure distribution *p*(*r*) in the tornado, assuming $p = p_\infty$ as $r \to \infty$. Find the location and magnitude of the lowest pressure.

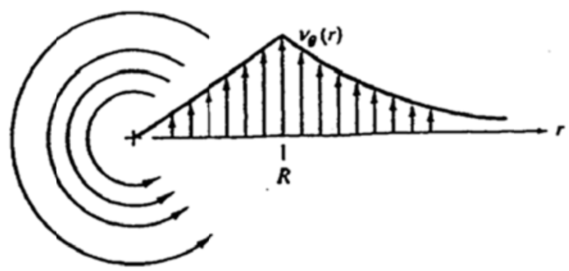
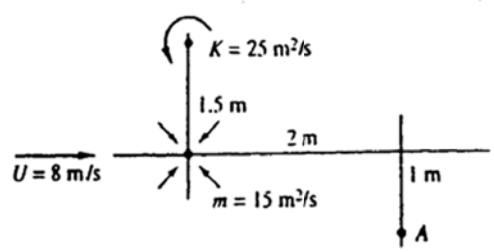


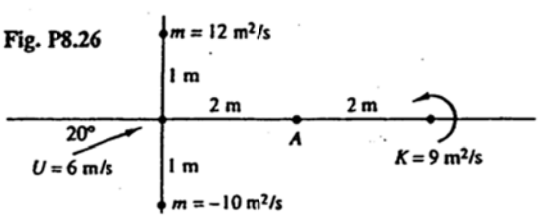
Fig. P8.14

5. Find the resultant velocity vector induced at point A in Fig. P8.23 due to the combination of uniform stream, vortex, and line source.
Sketch the resulting streamlines.



6. Find the resultant velocity induced at point A in Fig. P8.26 by the uniform stream, line source, line sink, and line vortex.
Sketch the resulting streamlines.

Fig. P8.26



7. Sources of equal strength m are placed at four symmetric positions (a,a), (-a,a), (a,-a), and (-a,-a). Sketch the streamline and potential line patterns. Do any "walls" appear?