Unit 9 - Week 7

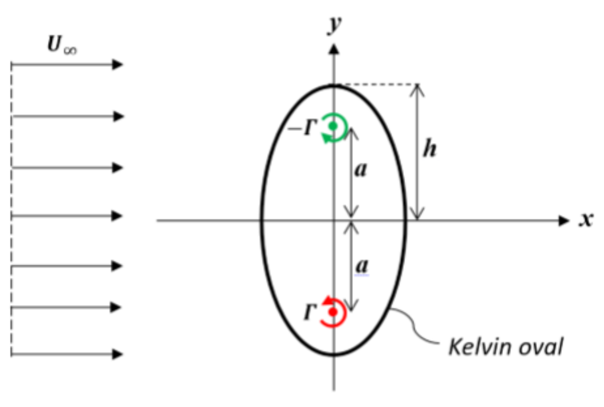
Assignment 7

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-09-18, 23:59 IST.

1) **Common Data for Questions 1 and 2:** *1 point*

A steady, two-dimensional flow formed by the superposition of a uniform stream of speed U_∞ in the positive x-direction, an irrotational counterclockwise vortex of strength Γ located at $(x, y) = (0, -a)$ where $a > 0$ and an irrotational clockwise vortex of equal strength Γ at $(x, y) = (0, a)$ mimics potential flow past a Kelvin oval as shown in the figure below. The pressure far upstream of the origin is p_∞.



The flow field can be characterized in terms of a complex potential, $F(z)$ defined by

$$\frac{dF}{dz} = u - iv = (v_r - iv_\theta)\, e^{-i\theta}$$

where $z = x + iy = re^{i\theta}$

The complex potential for an irrotational counterclockwise vortex of strength Γ located at (x_0, y_0) is

(A) $F(z) = \frac{\Gamma}{2\pi z}$

(B) $F(z) = -\frac{i\Gamma}{2\pi} \ln z$

(C) $F(z) = -\frac{i\Gamma}{2\pi} \ln(z - x_0 - iy_0)$

(D) $F(z) = \frac{\Gamma}{2\pi} \ln(z - x_0 - iy_0)$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
c

2) There is a closed streamline in this flow that defines the Kelvin oval. The equation of this streamline if $\Gamma = 2\pi U_\infty a$ is *1 point*

(A) $\frac{x}{a} = \frac{1}{2} \ln\left[\frac{(x+a)^2 + y^2}{(x-a)^2 + y^2}\right]$ (B) $\frac{y}{a} = \frac{1}{2} \ln\left[\frac{x^2 + (y+a)^2}{x^2 + (y-a)^2}\right]$

(C) $\frac{x}{a} = \frac{1}{2} \cot^{-1}\left(\frac{2ax}{x^2 + y^2 - a^2}\right)$ (D) $\frac{y}{a} = \frac{1}{2} \tan^{-1}\left(\frac{2ay}{x^2 + y^2 - a^2}\right)$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b

3) The hydrodynamic lift force on the Kelvin oval per unit depth perpendicular to the plane is *1 point*

(A) 0 (B) $\rho U_\infty \Gamma$

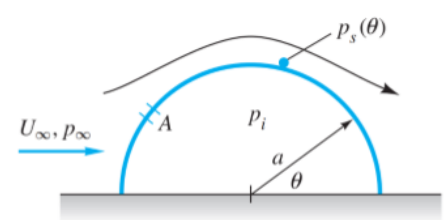
(C) $2\pi\rho U_\infty \Gamma$ (D) $6\rho U_\infty \Gamma$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

4) **Common Data for Questions 4 to 5:** *1 point*

Hurricane winds at an upstream speed U_∞ and pressure p_∞ blow over a Quonset hut, which is a long half-circular cylinder of radius a as shown in the figure below. The pressure inside the cylinder is p_i.



Assume the flow over the hut to be a constant density inviscid flow.

The net upward force on the hut per unit depth perpendicular to the plane assuming $p_i = p_\infty + \frac{1}{2}\rho U_\infty^2$ is

(A) $\rho U_\infty^2 a$

(B) $\frac{4}{3}\rho U_\infty^2 a$

(C) $\frac{5}{3}\rho U_\infty^2 a$

(D) $\frac{8}{3}\rho U_\infty^2 a$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
d

5) In strong winds the upward force on the hut can be quite large. Suppose that a hole is introduced in the hut roof at point A to make p_i equal to the surface pressure there. The angle θ at which A should be placed to make the net wind force zero is given by the equation: *1 point*

(A) $\cos^2\theta = \frac{1}{3}$

(B) $\sin^2\theta = \frac{1}{3}$

(C) $\sin^2\theta = \frac{1}{4}$

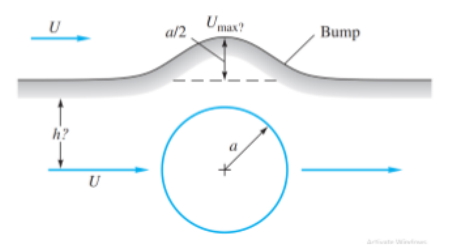
(D) $\cos^2\theta = \frac{1}{4}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

6) **Common Data for Questions 6 and 7:** *1 point*

It is desired to simulate flow past a two-dimensional ridge or bump by using a streamline that passes above the flow over a stationary cylinder, as shown in the figure below. The bump is to be $a/2$ high, where a is the cylinder radius.



What is the elevation h of this streamline?

(A) a

(B) $\frac{5a}{4}$

(C) $\frac{3a}{2}$

(D) $\frac{5a}{3}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
c

7) What is U_{max} on the bump compared with free stream velocity U? *1 point*

(A) U

(B) $\frac{5U}{3}$

(C) $\frac{3U}{2}$

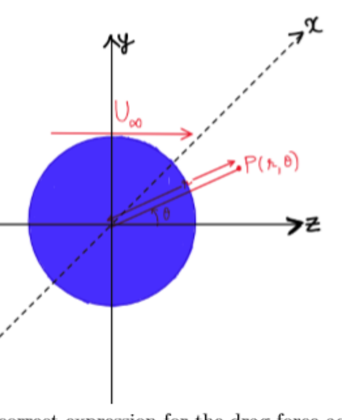
(D) $\frac{5U}{4}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
d

8) **Common Data for Questions 8 to 10:** *1 point*

Consider a smooth solid sphere of radius R translating through an unbounded stationary fluid of dynamic viscosity μ under the action of some external force with a constant speed U_∞ in the positive z-direction as shown in the figure below. The velocity of the sphere is small enough for the intertial terms in the Navier-Stokes equation to be neglected.



Which among the following is the correct expression for the drag force acting on the sphere in the negative z-direction, F_D in terms of the stress tensor components in the spherical polar coordinate system?

(A) $F_D = 2\pi R^2 \int_0^\pi (\tau_{r\theta}\sin\theta - \tau_{rr}\cos\theta)\sin\theta\, d\theta$

(B) $F_D = 2\pi R^2 \int_0^\pi (\tau_{r\theta}\cos\theta - \tau_{rr}\sin\theta)\sin\theta\, d\theta$

(C) $F_D = 2\pi R^2 \int_0^\pi (\tau_{r\theta}\cos\theta + \tau_{rr}\sin\theta)\sin\theta\, d\theta$

(D) $F_D = 2\pi R^2 \int_0^\pi (\tau_{r\theta}\sin\theta + \tau_{rr}\cos\theta)\sin\theta\, d\theta$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

9) The hydrodynamic lift force acting on the sphere is *1 point*

(A) $\pi\mu R U_\infty$

(B) $3\pi\mu R U_\infty$

(C) $6\pi\mu R U_\infty$

(D) 0

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
d

10) The contribution of the pressure forces and the viscous shear forces to the total drag on the sphere respectively are *1 point*

(A) $3\pi\mu R U_\infty$, $3\pi\mu R U_\infty$

(B) $2\pi\mu R U_\infty$, $4\pi\mu R U_\infty$

(C) $4\pi\mu R U_\infty$, $2\pi\mu R U_\infty$

(D) 0, $6\pi\mu R U_\infty$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b