

AAE 333 Final Exam

Wed Dec 15, 8AM-10AM

Open Book (Closed notes)

1 Crib Sheet (two sided)

Calculator allowed

Hand in Scratch work

Do not staple to Scantron

PUT YOUR Purdue ID ON THE SCANTRON !!!

Include 00

- 1) If c is the chord of an airfoil, U is the free stream velocity, p is the free stream pressure, ρ is the free stream density, ν is the kinematic viscosity and ζ is the vorticity, which of the following quantities is NOT nondimensional
 - a. $U/\sqrt{p/\rho}$
 - b. $U\zeta/c$
 - c. $c\zeta/U$
 - d. $c^2\zeta/\nu$
 - e. U^*c/ν

- 2) For what values of the constant s “ a ” and “ b ” do the velocity components $u = x^2 + ay^2$; $v = bxy + 4$ represent an incompressible and irrotational flow:
 - a. $(a,b)=(-1, -2)$
 - b. $(a,b)=(1, 2)$
 - c. $(a,b)=(-2, -1)$
 - d. $(a,b)=(2, 1)$
 - e. $(a,b)=(2, -1)$

- 3) The velocity potential of a uniform stream with speed 3m/s and a 2D source with strength $2 \text{ m}^2/\text{s}$ is
 - a. $3x + 2\ln(r)$
 - b. $-2y + 3\ln(r)$
 - c. $3x + \ln(r)/\pi$
 - d. $3y + 2\theta$
 - e. $3y - 2\theta/\pi$

- 4) Consider a 2D flow in the first quadrant, $x > 0$, $y > 0$.
 The velocity field is given by $u = 4y$, $v = 0$
 The volume flow rate (per unit span) through the line extending from $x = 0$; $y = 1$ to $x = 1$, $y = 0$ is
- 0
 - 1
 - 2
 - 1
 - 2
- 5) Given a density of 2 and a pressure field $p = 100 + 4xy$, the x and y components of acceleration, (a_x, a_y) , of a fluid particle as it moves through the point $x = y = 1$ are (neglecting viscous forces and gravity)
- [0,0]
 - [1,2]
 - [2,1]
 - [2,2]
 - [-2,-2]
- 6) Water of depth 1m is held back by a door hinged at the top of the water and extending down 1 m. The door is 3m wide. The torque (in Nm) acting on the door is closest to
- 0
 - 10
 - 100
 - 1000
 - 10000
- 7) Given a velocity potential $x^2 - y^2$, the z -vorticity component at the point $x = 2$, $y = 2$ is
- 4
 - 0
 - 4
 - 8
 - 8
- 8) An incompressible flow has a freestream speed of 50 m/s and a density of 2 kg/m^3 . The highest possible gage pressure the fluid can achieve is, in atmospheres (note: 1 atm is $1 \text{e}5 \text{ Pa}$)
- 250
 - 0.25
 - 0.05
 - 0.025
 - 0.005

9) What are the $\{x,y\}$ velocity components corresponding to the velocity potential $\phi = x y + 3$

- a. $u=2 y$, $v=2 x$
- b. $u= x$, $v=- y$
- c. $u=- y$, $v= x+3$
- d. $u=y$, $v=3$
- e. $u=y$, $v=x$

10) For the NACA 2414 airfoil, the location of the maximum camber, in fraction of chord, is

- a. .02
- b. .04
- c. .4
- d. .14
- e. .24

11) Incompressible potential flow over a circular cylinder has a max speed of twice the free stream without circulation. If sufficient circulation is added to make the velocity at the bottom point 0, the lift coefficient would be closest to

- a. 2
- b. 4
- c. 6
- d. 8
- e. 12

- 12) A 2D channel carries a fully developed laminar flow with a total volume flow rate of $2 \text{ m}^2/\text{s}$. The distance between the walls is 1 cm and the viscosity is 1.2 e-5 Kg/m/s . The tangential force exerted by the fluid on one square meter of each wall is (in Newtons):
- a. .12
 - b. 1.2
 - c. .144
 - d. 1.44
 - e. .6
- 13) The pressure on the lower side of a flat plate of length 3 is $3 \times^2$ and on the upper side is $-2 \times^2$. The resultant pressure force (per unit span) in the y -direction is
- a. 0
 - b. -45
 - c. 45
 - d. -15
 - e. 15
- 14) A 2D channel carries a fully developed laminar flow. The channel is 2 mm wide. When the volume flow rate is $0.2 \text{ m}^3/\text{s/m}$, the pressure is observed to drop 1.5 e4 Pa per meter along the channel. The viscosity of the fluid is (in MKS units):
- a. .5 e-4
 - b. 1 e-5
 - c. .5 e-5
 - d. 2 e-3
 - e. 4 e-4
- 15) A sphere of radius 1 m contains a gas of density $.1 \text{ kg/m}^3$. The sphere is immersed in a gas with density 1 kg/m^3 . The acceleration of gravity is 10 m/s^2 . The net upward force on the sphere, including both pressure and weight is closest to
- a. 10 N
 - b. 28 N
 - c. 38 N
 - d. 42 N
 - e. 64 N