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Courses » **Modeling Transport Phenomena of Microparticles**

Announcements **Course** Ask a Question Progress

Unit 2 - Week 1

Course outline

How to access the portal

Week 1

- Lecture1 : Preliminary concepts: Fluid kinematics, stress, strain
- Lecture 2:Cauchy's equation of motion and Navier-Stokes equations
- Lecture 3:Reduced forms of Navier-Stokes equations and Boundary conditions
- Lecture 4: Exact solutions of Navier-Stokes equations in particular cases
- Lecture 5: Dimensional Analysis – Non-dimensionalization of Navier-Stokes's equations
- Week 1 Lecture Material
- Quiz : Week 1 Assignment
- Week 1 Assignment Solution

Week 2

Week 3

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Week 1 Assignment

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

Due on 2017-02-08, 23:59 IST.

Modeling Transport Phenomena of Micro-particles
Assignment 1

Note: Follow the notations used in the lectures. Symbols have their usual meanings.

1) *1 point*

The material derivative at the point $(1, 1, 1)$ for the velocity field $\bar{u} = (yz + t, xz - t, xy)$ is a vector given by

A. $(3 - t, t, 2)$

B. $(3 - t, 1 - t, 2)$

C. $(3 + t, 1 + t, 2)$

D. $(3 - t, 1 + t, 2)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
D. $(3 - t, 1 + t, 2)$

2) *1 point*

If the velocity components of a three dimensional flow are given by $u = x^2 + y^2$, $v = -xy - yz - xz$, $w = g(x, y,$
then the expression for $g(x, y, z)$ so that the incompressibility condition is satisfied is of the form

A. $\frac{z^2}{2} - xz + f(x, y)$

B. $\frac{z^3}{3} - xz + f(x, y)$

C. $z^2 - xz + f(x, y)$

D. $\frac{z^2}{2} - yz + f(x, y)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
A. $\frac{z^2}{2} - xz + f(x, y)$

3) *1 point*

Consider the problem of steady flow between two infinite, parallel plane boundaries located at $y = 0$ and $y = 2$. Let us assume that the flow is uni-directional in the x-direction driven by a constant pressure gradient, $\frac{dp}{dx}$ which is equal to one. Both upper and lower boundaries are stationary. Compute the velocity assuming no-slip at the lower boundary and partial slip at the upper boundary. The corresponding maximum velocity $|u_{max}|$, when the slip coefficient, $\lambda = \frac{1}{2}$ is

A. $\frac{4}{9}$

B. $\frac{2}{9}$

C. $\frac{1}{9}$

D. $\frac{3}{9}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
B. $\frac{2}{9}$

4) **1 point**

If an impermeable rigid surface is moving with a velocity $\mathbf{U}$ and $\mathbf{u}$ denotes the fluid velocity, then the kinematic boundary condition that a fluid in contact with this surface is

A. $\mathbf{U} \cdot \mathbf{n} = 0$

B. $(\mathbf{u} - \mathbf{U}) \cdot \mathbf{n} = 0$

C. $\mathbf{u} = 0$

D. $\mathbf{u} \cdot \mathbf{n} = 0$

No, the answer is incorrect.
Score: 0

Accepted Answers:
B. $(\mathbf{u} - \mathbf{U}) \cdot \mathbf{n} = 0$

5) **1 point**

Consider the equation of motion of a unidirectional flow given by $-\frac{dp}{dx} + \mu\frac{d^2u}{dy^2} - \frac{\mu}{K}u = 0,$ where K is a constant. Introduce suitable characteristic quantities to non-dimensionalize the variables involved, then non-dimensionalize the above equation. Hence, the dimension of K would be

A. L^2

B. L

C. L^3

D. L^{-1}

No, the answer is incorrect.
Score: 0

Accepted Answers:
A. L^2

6) **1 point**

If the force F experienced on a partially submerged body depends upon the velocity $V,$ length of the body $L,$ viscosity of the fluid μ and density of the fluid $\rho,$ then using Buckingham's π theorem, the number of non-dimensional groups, n and one of those non-dimensional groups π_1 are

A. $n = 1, \pi_1 = \frac{F}{V^2L^2\rho}$

B. $n = 2, \pi_1 = \frac{F}{VL^2\rho}$

C. $n = 2, \pi_1 = \frac{F}{V^2L^2}$

D. $n = 2, \pi_1 = \frac{F}{V^2L^2\rho}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
D. $n = 2, \pi_1 = \frac{F}{V^2L^2\rho}$

7) **1 point**

Consider a fluid flow with the velocity components in (r, θ, z) cylindrical coordinates given by $u_r = 0, \quad u_\theta = \frac{\Omega}{2}r$ $(\Omega : constant), \quad u_z = 0$. Write down the simplified Navier-Stokes equations and integrate the same to obtain the corresponding pressure, p. If $p = 0$ at $r = 2,$ then the expression for the pressure obtained is

A. $\frac{\rho\Omega^2}{2}\left(\frac{r^2}{4} - r\right)$

B. $\frac{\rho\Omega^2}{2}\left(\frac{r^2}{4} - 1\right)$

C. $\frac{\rho\Omega^2}{2}\left(\frac{r^2}{2} - r\right)$

D. $\frac{\rho\Omega^2}{2}\left(\frac{r^2}{2} - 1\right)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
B. $\frac{\rho\Omega^2}{2}\left(\frac{r^2}{4} - 1\right)$

8) *1 point*

If the velocity vector corresponding to a three-dimensional viscous incompressible flow is given by $\mathbf{u} = (yz -$
then the tangential stress components $(\tau_{xy}, \tau_{yz}, \tau_{zx})$ respectively are

A. $(z, 1, y)$

B. $(1, y, z)$

C. $(y, z, 1)$

D. $(z, -1, y)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
A. $(z, 1, y)$

9) *1 point*

Consider the Euler's equation of motion for the incompressible inviscid flow. If the velocity field corresponding to such a flow is given by $\mathbf{u} = (x, -y),$ then the expression for the pressure up to a constant (in the absence of body fc

A. $\frac{1}{2}(y^2 + x^2)$

B. $\frac{1}{2}(y - x^2)$

C. $\frac{1}{2}(y^2 - x^2)$

D. $\frac{1}{2}(y^2 - x)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
C. $\frac{1}{2}(y^2 - x^2)$

10) *1 point*

Consider the Hagen-Poiseuille flow inside a circular tube. If the maximum velocity, u_{max} and the average velocity, u_{avg} are related by $au_{max} + bu_{avg} = 0,$ then the values of a and b respectively are

A. $a = -1, \ b = 2$

B. $a = 2, \ b = -1$

C. $a = -1, \ b = 1$

D. $a = 1, \ b = 1$

No, the answer is incorrect.
Score: 0

Accepted Answers:
A. $a = -1, \ b = 2$

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