Subject: Math: IV-VI(vi)/IX-XI(vi) **M.A/M.Sc: Part- II / Composite, 1st -A/2011**

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University of Sargodha

M.A/M.Sc Part-II / Composite, 1st -A/2011

Math: IV-VI(vi)/IX-XI(vi) **Fluid Mechanics**

Maximum Marks: 40 **Fictitious #:** _______

Time Allowed: 45 Min. ***Objective Part*** **Signature of CSO:** _______

Note: **Cutting, Erasing, overwriting and use of Lead Pencil are strictly prohibited. Only first attempt will be considered.**

Q. 1

A: Choose the correct options. **(05)**

i. In the absolute Metric system the basic unit of Dynamic viscosity is ________

a) Stoke b) Poise c) cm^2/s

ii. Gravitational force is a ________ force:

a) Surface b) Body c) Magnetic

iii. Equation of continuity for an incompressible fluid is________

a) $\vec{\nabla}\cdot e\vec{\nabla}=0$ b) $\vec{\nabla}\cdot\vec{V}=0$ c) $\vec{\nabla}\times\vec{V}=0$

iv. Dimension of viscosity is_________

a) $\left[\frac{FT^2}{L^4}\right]$ b) $\left[\frac{L^4}{FT^2}\right]$ c) $\left[\frac{L^4F}{T^2}\right]$

v. Necessary and sufficient conditions for a potential flow is ________

a) $\vec{\nabla}\times\vec{V}=0$ b) $\vec{\nabla}\cdot\vec{V}=0$ c) $c\cdot\vec{V}=0$

B: Fill in the Blanks. **(05)**

i. If the total flow across a surface enclosing the source is $2\pi m$, then m is called __________ of the source in two dimensions.

ii. A doublet is a limit combination of a _____________ and _____________ of equal lengths.

iii. Equation of surface perpendicular to the stream line is___________.

iv. A perfect fluid is that for which viscosity is ______________.

v. $\frac{\partial u}{\partial x}$ and $\frac{\partial v}{\partial x}$ cause ____________________ deformation.

C: Write true or false. (10)

i. Dimensions of stream function are $\left[\dfrac{L^2}{T}\right]$.

ii. For an irrotational motion, $\vec{\Omega} \neq 0$.

iii. For an unsteady flow, equation of continuity is $\dfrac{\partial \eta}{\partial t} = 0$, where η is a fluid property is.

iv. The equations of motion for an ideal fluid are Euler's equations.

v. Surface tension is caused by the force of adhesion at the free surface.

Q. 2 Give short answer of the following: **(20)**

i. What is the value of complex velocity at a stagnation point?

ii. Show that $1.00\,kg$ weights $9.80\,N$ on earth.

iii. What type of deformation is caused by the cross velocity gradients $\dfrac{\partial u}{\partial y}, \dfrac{\partial v}{\partial x}$?

iv. State the law of conservation of energy.

v. Given that $\vec{V} = \dfrac{k^2(x\hat{j} - y\hat{i})}{x^2 + y^2}$ (k = constant). Show that the equations of the stream lines are circles for the given velocity field.

University of Sargodha

M.A/M.Sc Part- II/Composite, 1st -A/2011

Math: IV-VI(vi)/IX-XI(vi) Fluid Mechanics

Maximum Marks: 60 **Time Allowed: 2:15 Hours**

Subjective Part

Note: **Attempt any three questions. All questions carry equal marks.**

Q. 3	**a)** Define viscosity and show the relationship between the shear stress and the rate of shear deformation. Also write Newton's law of viscosity.	**(10)**
	b) The space between two square flat parallel plates is filled with oil. Each side of the plate is 720mm. The thickness of the oil is 25mm, the upper plate moves at 3m/s requires a force of 120N to maintain the speed. Determine (a) The dynamic viscosity of the oil. (b) The kinematics viscosity of the oil if specific gravity of oil is 0.95.	**(10)**
Q. 4	**a)** Derive the Poisson's and Laplace equations for a two dimensional, incompressible flow in the $r\theta-$Plane and also show the relation between the stream function Ψ and velocity potential φ.	**(10)**
	b) Show that the flow is rotational or irrotational for considering the flow field $\Psi = ax^2 - ay^2$, where $a = 11\sec^{-1}$. Also determine the velocity potential for this flow and show their orthogonality.	**(10)**
Q. 5	**a)** Show the equations of motion for frictionless flow in gradient form.	**(10)**
	b) A liquid flows down an inclined plane surface in a steady, fully developed laminar film of thickness h. Simplify the continuity and Navier-Stokes equations to model this flow field. Obtain expressions for the liquid velocity profile and the shear stress distribution.	**(10)**
Q. 6	**a)** Consider an infinite long flat plate over which a fluid exists. Initially both the plate and the fluid are at rest. Suddenly the plate is jerked into motion into its own plane with a constant velocity V. Derive the governing equation and write the appropriate boundary conditions.	**(10)**
	b) The y component of velocity in a steady, incompressible flow field in the xy-plane is $V = -Bxy^3$ where $B = 0.3\, m^{-3}S^{-1}$ and x and y are measured in meters. Find the simplest x-component of velocity for this flow field. Find the equation of the stream lines for this flow.	**(10)**
Q. 7	**a)** Discuss different measure of boundary layer thickness.	**(10)**
	b) A wide moving belt is moving through a container of a viscous fluid. The belt moves vertically upward with a constant velocity, V_0. Because of viscous forces the belt picks up a film of fluid of thickness h. Gravity tends to make the fluid drain down the belt. Use the Navier-Stokes equations to determine an expression for the average velocity of the fluid film as it is dragged up the belt. Assume that the flow is laminar, steady and fully developed.	**(10)**