Registration No: | | | | | | | | | | |

Total Number of Pages: 02

M.TECH
P2HTCC14

2nd Semester Regular Examination 2016-17
Advanced Fluid Mechanics
BRANCH: HEAT POWER & THERMAL ENGG, HEAT POWER ENGG, THERMAL ENGG
Time: 3 Hours
Max Marks: 100
Q.CODE:Z951
Answer Question No.1 which is compulsory and any FOUR from the rest.
The figures in the right hand margin indicate marks.

Q1 **Answer the following questions:** ***Short answer type*** **(2 x 10)**

a) What is volumetric dilation? Write volumetric dilation in terms of linear strain rate of a fluid element.

b) Define vorticity and circulation.

c) Write the constitutive relation in a fluid flow field.

d) If the symmetric and anti-symmetric tensor are given as A_{ij} and S_{ij}, show that $A_{ij}S_{ij} = 0$.

e) Why is the viscosity of air increases with temperature; whereas the viscosity of a liquid decreases with temperature.

f) A student needs to measure the pressure at two different locations in a highly turbulent flow by using Bernoulli's equation. Can he be able to do that? Explain your answer.

g) For a hydrostatic fluid, show that the thermodynamic pressure is equal to hydrostatic pressure.

h) What do you mean by closure of turbulence?

i) Define isotropic turbulence.

j) What changes one has to make to get Euler's equation from Navier Stokes equation? Also write Euler's equation for three-dimensional flow filed for a laminar, incompressible flow.

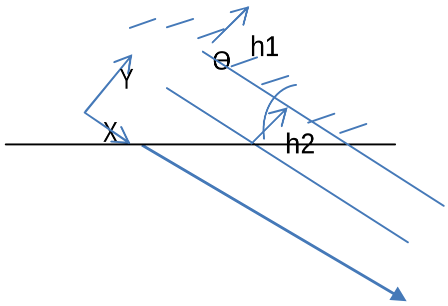
Q2 **a)** A fully developed laminar flow is taking place in the annulus between two concentric pipes. The inner pipe is stationary, and the outer pipe is moving in the axial direction with a velocity V_0. Assume the axial pressure gradient to be zero (i.e., $dp/dz = 0$). Find out a general expression for shear stress as a function of radial coordinate. **(10)**

b) Find the general expression for the velocity profile $V_z(r)$ for the above case. **(10)**

Q3 **a)** A fully developed laminar flow is taking place in the annulus between two concentric pipes. The inner pipe is stationary, and the outer pipe is moving in the axial direction with velocity Vo. Assume the axial pressure gradient to be zero. Find out the general expression for shear stress as a function of radial coordinate. Also find out the general expression for the velocity profile. **(10)**

b) If the velocity gradient tensor is represented by $\overline{\overline{G}}$, then find out the rate-of-deformation tensor $\overline{\overline{D}}$ from the velocity gradient tensor. **(10)**

Q4	**a)**	Consider a flow field defined by, and $u = x(1+t)$, $v = 1$ and w=0. Find the equation for streamline passing through the point (1, 1) and t=0.	**(10)**
	b)	Also, find the equation for path line passing through the same point and at the same time. Find the equation of streakline that passes through the point (1,1).	**(10)**
Q5	**a)**	Consider a two-dimensional boundary layer flow over a solid impermeable wall. The wall is located at y=0. Show that $\frac{\partial u}{\partial y}(x,0) = \frac{\tau_w}{\mu}$.	**(10)**
	b)	For the above case also show that $\frac{\partial^2 u}{\partial y^2}(x,0) = \frac{1}{\mu}\frac{dP}{dx}$ and $\frac{\partial^3 u}{\partial y^3}(x,0) = 0$	**(10)**
Q6	**a)**	Consider a double layer of immiscible fluids 1 and 2, flowing steadily down an inclined plane as shown in blow figure. The atmosphere present above the fluid 2 exerts no shear stress on the surface and is at constant pressure. Find the laminar velocity distribution in the two layers.	**(10)**



	b)	Derive momentum integral equation for two-dimensionalflow over a flat plate, and use this Equation to show that $\delta = \frac{5.83x}{\sqrt{\mathrm{Re}_x}}$. Use the profile for velocity as: $\frac{u}{U_\infty} = a_0 + a_1\eta + a_2\eta^2 + a_3\eta^3 + a_4\eta^4$; $\eta = y/\delta$.	**(10)**
Q7	**a)**	Use Prandtl's mixing length hypothesis $-\rho\overline{u'v'} = \rho l^2 \left\|\frac{\partial u}{\partial y}\right\|\frac{\partial u}{\partial y}$ to determine the mean velocity profile in fully turbulent constant stress layer of inner region of a turbulent boundary layer. Assume that mixing length is given by $l = ky$, where k is a constant.	**(10)**
	b)	Derive velocity defect law.	**(10)**