Registration no: | | | | | | | | | | |

Total Number of Pages: 02 **M.TECH**

HTPC101

1st Semester Regular/Back Examination 2016-17
ADVANCED FLUID MECHANICS
SPECIALISATION: HEAT POWER & THERMAL ENGINEERING

Time: 3 Hour

Max marks: 70

Q Code:Y848

Answer Question No.1 which is compulsory and any five from the rest.

The figures in the right hand margin indicate marks.

Q1 (2x10)

a) What is uniform flow?

b) What is a path line?

c) Write the equation of continuity for incompressible flow in two dimension.

d) What is Stoke's flow?

e) Write the vorticity in vector form. What is its relation with angular velocity components?

f) Write the formula for head loss by fluid due to friction on solid surface.

g) Which property of the fluid is responsible for development of boundary layer on a solid surface when the fluid flows? Define thickness of the boundary layer.

h) Define the fluctuation velocity in turbulent flow. Write the relationship between average velocity and fluctuation velocity.

i) State the difference between series solution and numerical solution?

j) Write the velocity components in terms of velocity potential.

Q2 a) Verify whether the following flow fields are rotational. If so, determine the components of rotation about various axes: (5)

$(i)\ u = xyz, v = zx, w = yz - xy^2$; $(ii)\ u = xy, v = 0.5\left(x^2 - y^2\right), w = 0$.

b) Describe the Lagrangian and Eulerian approach of flow field. With explanation find out the existent of the temporal and convective components of acceleration for: (i) steady and uniform flow, (ii) steady and non-uniform flow, (iii) unsteady and uniform and (iv) unsteady and non-uniform flow. Write the expressions for temporal and convective accelerations in two dimensional flow. (5)

Q3 a) Derive the equation of continuity in differential form for compressible flow. (5)

b) In a Couette flow, the bottom plate is stationary and top plate is moving with velocity U. Taking 'h' is the distance between two plates and the fluid is held stationary between two parallel plates, find out the velocity profile (u) along x-direction. Assume $u \neq 0, v = w = 0$ and $\frac{\partial u}{\partial z} = 0$. (5)

Q4 Assuming a velocity profile in the form $u/U_\infty = a_0 + a_1\eta + a_2\eta^2 + a_3\eta^3$, where a_0, a_1, a_2, a_3 are constants and $\eta = \dfrac{y}{\sqrt{vx/U_\infty}}$ = non-dimensional parameter, *x,y* are co-ordinates and v and U_∞ are kinematic viscosity of fluid and free stream velocity of flow over a flat plate. Using suitable boundary layer flow theory, find out the momentum thickness for the flat plate. Assume the boundary conditions for calculation as: (10)

at $\eta = 0, u/U_\infty = 0$; at $\eta = 0, u/U_\infty = 0$; at $\eta = 1, u/U_\infty = 1$; at $\eta = 1, \dfrac{\partial\left(u/U_\infty\right)}{\partial\eta} = 0$; The equation for displacement thickness is given by: $\delta^{**} = \int_0^\delta \dfrac{u}{U_\infty}\left(1 - \dfrac{u}{U_\infty}\right)dy$, δ = boundary layer thickness.

Q5 a) Write short notes of the following. (i) homogeneous turbulence, (ii) isotropic turbulence, and (iii) intensity of turbulence. (5)

b) Write Reynolds stress matrix for turbulent flow and write the expressions for individual components in a three dimensional flow field. (5)

Q6 a) If non-dimensional parameter $= \eta = \dfrac{y}{\sqrt{vx/U_\infty}}$ and $u = f'(\eta)U_\infty$. Calculate the local skin friction coefficient and total drag force per unit width for flow over a flat plate. (Assume $f''(\eta) = 0.3326$ at $\eta = 0$), where, x y are coordinate axes, v = kinematic viscosity, U_∞ = free stream velocity of flow over the plate. (7)

b) Write the stress representation for a cubic body and show its directions. (3)

Q7 a) Write Reynolds –Transport equation with proper explanation of symbols used in it. Write its application on: (i) conservation of mass, (ii) conservation of momentum and (iii) conservation of energy. (2.5 +7.5)

Q8 Write short notes of the following (2.5x4)

a) Stream line
b) Stream tube
c) Translation of flow
d) Rotation of flow.