Reg.No. _____________

Karunya UNIVERSITY

(Karunya Institute of Technology & Sciences)

(Declared as Deemed-to-be University under Sec.3 of the UGC Act, 1956)

End Semester Examination – April/May – 2017

Code : 15AE3002 **Duration : 3hrs**

Sub. Name : Boundary Layer Theory **Max. marks : 100**

ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)

Q. No.	Sub Div.	Questions	Course Outcome	Marks
1.	a.	Derive the momentum equation for viscous incompressible fluid in Cartesian coordinates system.	CO 1	20
		(OR)		
2.	a.	Derive continuity equation in cylindrical polar coordinates system (r, θ, z).	CO1	10
	b.	Derive the expression for viscous stress for fluid in cylindrical polar coordinates system (r, θ, z).	CO1	10
3.	a.	Consider the viscous fluid confined with two infinite plates extending in x and z direction. Plates are at a distance of H from each other. Let there be constant pressure gradient $\frac{dp}{dx}$ along x-direction. Simplify the governing equations and get the velocity profile of fluid confined within the plates.	CO2	20
		(OR)		
4.		Consider the fluid confined within a pipe of radius R with constant pressure gradient $\frac{dp}{dz}$ along axial direction z. The velocity vector is given by $\vec{V} = -\frac{1}{4\mu}\frac{dp}{dz}(R^2 - r^2)\,\vec{e_z}$. Verify that	CO2	
	a	It satisfies the continuity equation.		8
	b	It satisfies the momentum equation.		12
5.	a.	Derive the Boundary layer equations from Navier-Stokes equations in Cartesian coordinate system in 2-dimensions (x,y).	CO2	20
		(OR)		
6.	a.	Derive Falkner-Skan equation from boundary layer equations for similarity solution.	CO2	20
7.	a.	In a boundary layer, the velocity profile is given by $\frac{u}{U} = a + b\,\frac{y}{\delta} + c\left(\frac{y}{\delta}\right)^3 + c\left(\frac{y}{\delta}\right)^4$, where U is velocity at the edge of boundary layer and δ is boundary layer thickness. Derive the values of the various constants in the profile using appropriate boundary conditions, Assume that there is no pressure gradient.	CO3	20
		(OR)		
8.		In a boundary layer, the velocity profile is given by $\frac{u}{U} = \frac{n}{n-1}\frac{y}{\delta} - \frac{1}{n-1}\left(\frac{y}{\delta}\right)^n$, where U is velocity at the edge of boundary layer and δ is boundary layer thickness. Determine	CO3	
	a	Dispacement thickness δ^*		10
	b	Momentum Thickness θ		10

9.	a.	Consider incompressible turbulent flow in a 2D channel with channel along x-axis. The height of channel is along y-axis and velocities are (u,v) along (x,y)axis. Using the condition of symmetry of flow in the channel, show that fully developed turbulent flow in channel is governed by following equation. $$\mu \frac{\partial^2}{\partial y^2} \bar{u} - \rho \frac{\partial}{\partial y} (\overline{u'v'}) = \frac{\partial}{\partial x} \bar{p}$$ $$\rho \frac{\partial}{\partial y} (\overline{v'v'}) + \frac{\partial}{\partial y} \bar{p} = 0$$	CO3	20

ALL THE BEST