Form A: Paper-setting Blank Ref. No. EX/PE/PE/H/T/422E/2023

B.E. Power Engineering 4th year Examination, 2023
2nd Semester
Subject: Advanced Topics in Fluid Mechanics

Time: Three hours Full marks: 100

Answer any 5 question

No. of questions		Marks
1.	The velocity distribution in a fluid is given by $\overline{U} = a(x^2 - y^2)\hat{i} - 2axy\,\hat{j}$ Show that the fluid is incompressible. Using momentum equation, derive expression for the pressure distribution in the fluid assuming gravitational force as the only body force.	5+15
2.	What is Stokes theorem for circulation? Prove Stokes theorem. Does a velocity field given by $\overline{U} = 5x^2\,\hat{i} - 15x^2 y\,\hat{j} + t\hat{k}$ represent a possible 3-D motion of an incompressible fluid?	4+8+8
3.	From 1st law of thermodynamics show that $\rho\left(\frac{De}{Dt}\right) = \left(\frac{\partial q_i}{\partial x_i}\right) + f_{Bi}U_i + \frac{\partial}{\partial x_j}\left(\tau_{ji}U_i\right)$ symbols have their own meaning.	
4.	What do you mean by strain rate tensor? State the properties of stress tensor. Show that the Eulers' equation of motion can be expressed in Cartesian tensor coordinate system as $-\frac{\partial p}{\partial x_i} + f_{Bi} = \rho\left[\frac{\partial U_i}{\partial t} + U_j\frac{\partial U_i}{\partial x_j}\right]$ Symbols have their own meanings. State all the assumptions.	
5.	A horizontal rectangular duct of $1m^2$ cross-sectional area bends by 45°. The area of the duct is gradually reduced to $0.5m^2$. The velocity of air (specific weight = $0.0116kN/m^3$) at $1m^2$ end is 10m/s and pressure is $30kN/1m^2$. Find the magnitude and direction of force required to hold the duct in position. Use Reynolds Transport Theorem.	7+8
6.	What do you mean by bulk viscosity and 2nd coefficient of viscosity? Prove that circulation of radius r, vorticity is twice the mean angular	

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	velocity. Prove that for the volumetric deformation in a 2-D fluid flow $\sigma_{xx} = \frac{1}{2}\varepsilon_{xx}$, symbols have their own meanings.	2+5+8
7.	What do you mean by extensive and intensive property? Show their relationship. Derive Reynolds Transport Theorem. Using this, find the continuity equation for steady, incompressible fluid flow.	
8.	Find the expression of velocity profile of the flow between two concentric cylinders while the outer cylinder with infinite radius is stationary. Draw the characteristic curves of non-Newtonian fluids with yield stress at zero velocity gradient.	15+5