

BE Power Engineering 4th Year Examination, 2022
2nd Semester

Subject: Advanced Topics of Fluid Mechanics³(Hons)

Time: Three hours

Full marks: 100

Answer any 5 question

No. of questions		Marks
1.	<p>The velocity distribution in a fluid is given by</p> $\vec{U} = a(x^2 - y^2)\hat{i} - 2axy\hat{j}$ <p>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.</p>	5+15
2.	<p>What is Stokes theorem for circulation? Prove Stokes theorem. Does a velocity field given by $\vec{U} = 5x^2\hat{i} - 15x^2y\hat{j} + t\hat{k}$ represent a possible 3-D motion of an incompressible fluid?</p>	4+8+8
3.	<p>From 1st law of thermodynamics show that</p> $\rho \left(\frac{De}{Dt} \right) = \left(\frac{\partial q_i}{\partial x_i} \right) + f_{Bi}U_i + \frac{\partial}{\partial x_j} (\tau_{ji}U_i)$ <p>symbols have their own meaning.</p>	20
4.	<p>What do you mean by stress tensor? State the properties of stress tensor. Show that the Euler's equation of motion can be expressed in Cartesian tensor coordinate system as</p> $-\frac{\partial p}{\partial x_i} + f_{Bi} = \rho \left[\frac{\partial U_i}{\partial t} + U_j \frac{\partial U_i}{\partial x_j} \right]$ <p>Symbols have their own meanings. State all the assumptions.</p>	2+2+16
5.	<p>A horizontal rectangular duct of 1m² cross-sectional area bends by 45°. The area of the duct is gradually reduced to 0.5m². The velocity of air (specific weight = 0.0116kN/m³) at 1m² end is 10m/s and pressure is 30kN/m². Find the magnitude and direction of force required to hold the duct in position. Use Reynolds Transport Theorem.</p>	20
6.	<p>Prove that for the volumetric deformation in a 2-D fluid flow</p> $\sigma_{xx} = \frac{1}{2} \epsilon_{xx}$ <p>symbols have their own meanings.</p> <p>What do you mean by extensive and intensive property? Show their relationship.</p> <p>Derive Reynolds Transport Theorem. Using this, find the continuity equation for steady, incompressible fluid flow.</p>	2+5+3+10