



Assignment 2

Fluid Mechanics (MA51003, MA40011)

Deadline: 29.10.21

Autumn 2021-22

Max mark: 20

Attempt all questions. First four questions are of 3 marks and the last two questions are of 4 marks.

1. A velocity field is given by $\mathbf{q} = -x\mathbf{i} + (y + t)\mathbf{j}$. Find the stream function and the stream lines for this field at $t = 2$.
2. A circular cylinder is fixed across a stream of velocity U with circulation k round the cylinder. Show that the maximum velocity in the liquid is $2U + \frac{k}{2\pi a}$, where $a > 0$ is radius of the cylinder.
3. The stress matrix at a point is given by

$$\sigma = \begin{bmatrix} 7 & -5 & 0 \\ -5 & 3 & 1 \\ 0 & 1 & 2 \end{bmatrix}$$

Determine the stress vector on the plane passing through P and having for its equation $x/4 + y/2 + z/6 = 1$.

4. Determine the principal stresses for

$$(i) \quad \sigma = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

$$(ii) \quad \sigma = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix}$$

5. If $u(x, y) = \frac{ax-by}{x^2+y^2}$, $v(x, y) = \frac{ay+bx}{x^2+y^2}$, $w = 0$. Determine the nature of motion of the fluid. Also, determine the velocity potential and pressure at any point (x, y) .
6. Within a circular boundary of radius a there is a two-dimensional liquid motion due to source of strength $m/2\pi$, at a distance f from the center, and an equal sink at the center. Find the velocity potential and resultant pressure.