PART II

Answer **THREE** *questions in this part.*

Each question carries 20% of the total examination marks.

Question 7

(i) Consider the time-dependent flow of a fluid whose velocity vector field $\mathbf{u} = u_1\mathbf{i} + u_2\mathbf{j}$ with Cartesian components is

$$u_1 = -2y \quad \text{and} \quad u_2 = 2xt.$$

Is the flow (a) incompressible, (b) irrotational, (c) steady? Give reasons for your three answers. [5]

(ii) Write down the equations describing the stream function for the velocity vector field in Part (i). Hence find the stream function for this flow. Sketch some of the streamlines at $t = 1$, showing the direction of flow. [7]

(iii) Consider the flow of an inviscid fluid of constant density ρ given by the velocity vector field of Part (i) with body force (per unit mass)

$$\mathbf{F} = 2x\mathbf{j}.$$

Find the pressure distribution in the fluid (to within an arbitrary function of time) and hence show that the pressure along any streamline at $t = 1$ is constant. [8]