GATE QUESTION

August 30, 2024

Question

1. Let $\rho(x, y, z, t)$ and $\mathbf{u}(x, y, z, t)$ represent density and velocity,respectively,at a point (x, y, z) and time t.Assume $\frac{\partial \rho}{\partial t}$ is continuos.Let V be an arbitrary volume in space enclosed by the close surface S and $\hat{n}$ be the outward unit normal of S.
   Which of the following equations is/are equivalent to $\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{u}) = 0$?

   (A) $\int_V \frac{\partial \rho}{\partial t} dv = -\oiint_S \rho \mathbf{u} \cdot \hat{n} ds$

   (B) $\int_V \frac{\partial \rho}{\partial t} dv = \oiint_S \rho \mathbf{u} \cdot \hat{n} ds$

   (C) $\int_V \frac{\partial \rho}{\partial t} dv = -\int_V \nabla \cdot (\rho \mathbf{u}) dv$

   (D) $\int_V \frac{\partial \rho}{\partial t} dv = \int_V \nabla \cdot (\rho \mathbf{u}) dv$